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1991

Draft Environmental Impact Statement

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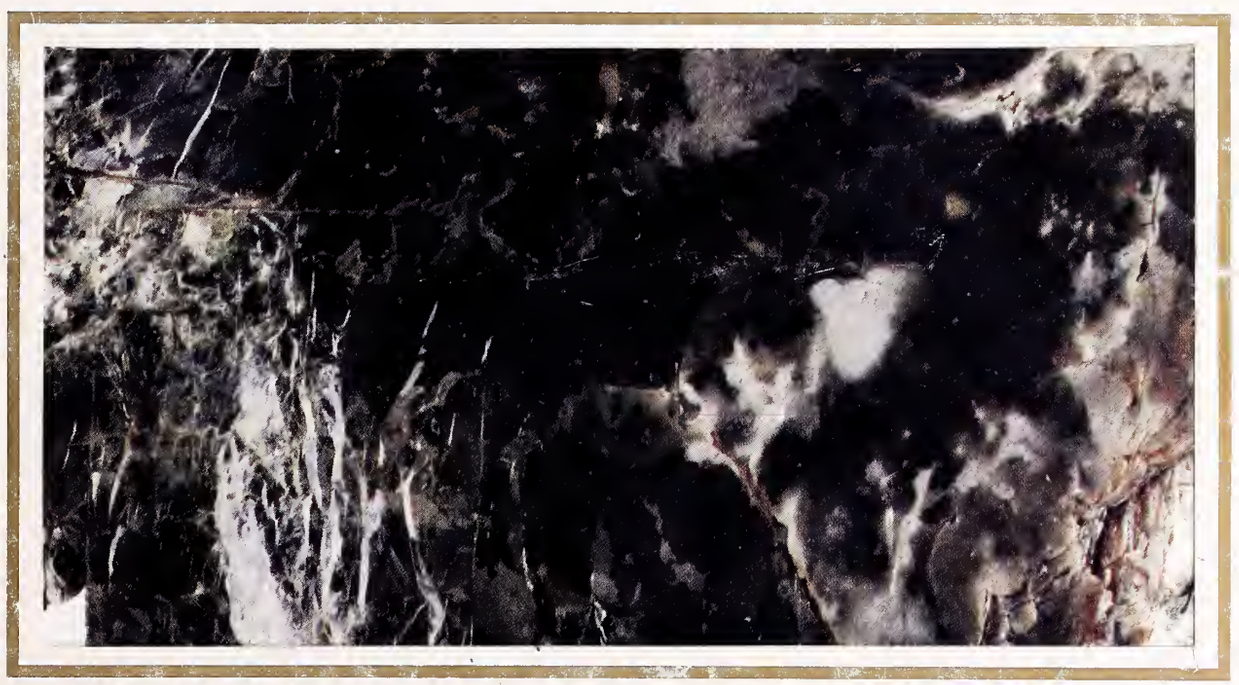

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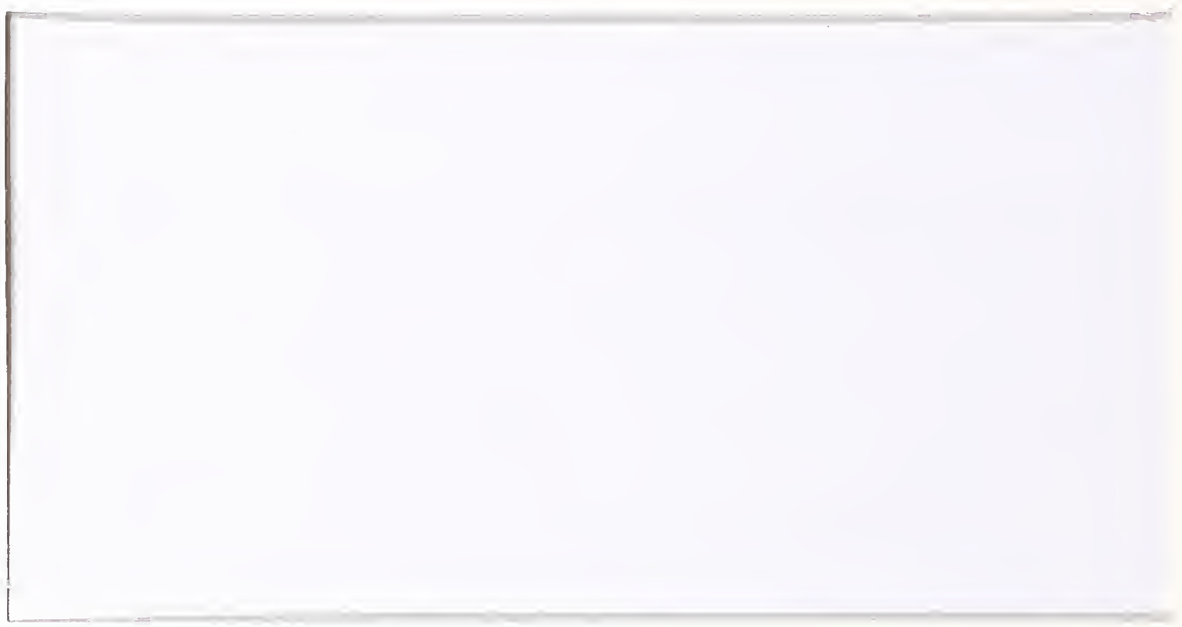

Vermiculite

A group of micaceous hydrated silicates of varying composition, which when heated, expand dramatically to lightweight particles. Vermiculite has many commercial uses including heat insulation, filtration, soil additive and product formulation.

due
JAN 10 1996

TYPE OF STATEMENT

Draft Environmental Impact Statement

PROPOSED ACTION

Construction and Operation of the Western Vermiculite Project

LEAD AGENCIES

U.S. Forest Service, Bitterroot National Forest
Montana Department of State Lands

COOPERATING AGENCIES

U.S. Fish and Wildlife Service
State Historic Preservation Office
U.S. Army Corps of Engineers
Montana Department of Health and Environmental Sciences -
Air Quality Bureau, Water Quality Bureau
Montana Department of Fish, Wildlife, and Parks

ABSTRACT

The Western Vermiculite Project Environmental Impact Statement describes the environmental resources and communities which may potentially be affected by development and operation of an open pit vermiculite mine. The required U.S. Forest Service action is to make a determination regarding the Plan of Operations submitted for the project. The required Montana Department of State Lands action is to approve, approve with modifications, or disapprove the Amendment to Operating Permit No. 00094.

The project consists of an open pit mine, ore concentrator, host rock waste stockpile, water storage tanks, and administrative and maintenance buildings. Three alternatives evaluated in this draft EIS include the proposed action, modifications to the proposed action, and no action.

COMMENT PERIOD

This is a draft Environmental Impact Statement open to public comment and review for 45 days following publication on February 1, 1991, of the Notice of Availability in the Federal Register. Comments should be directed to Ms. Winnie Schreiber, Bitterroot National Forest or Ms. Jo Stephen, Montana Department of State Lands at the addresses listed below. Informational and comment meetings to discuss the health risk assessment and the EIS will be held in Hamilton and Butte approximately 25 days after publication of the draft EIS. For further information, please contact:

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Capitol Station
Helena, MT 59620
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SUMMARY

This document summarizes the information contained in the draft Environmental Impact Statement (EIS) for the proposed Western Vermiculite Project. More detailed information can be obtained by reviewing the draft EIS document, which either follows or is available from the following persons:

- Winnie Schreiber, U.S. Forest Service, Darby, Montana
- Jo Stephen, Montana Department of State Lands, Helena, Montana

A copy of the draft EIS can be reviewed at the following locations:

- Northern Regional Office, U.S. Forest Service, Missoula, Montana
- Darby Ranger Station, Darby, Montana
- Supervisor's Office, Bitterroot National Forest, Hamilton, Montana
- Montana Department of State Lands, Helena, Montana
- Ravalli County Library, Hamilton, Montana
- Missoula City/County Library, Missoula, Montana

PROPOSED ACTION

The Western Vermiculite Project would consist of an open pit vermiculite mine, a concentrator, related surface facilities, and a haul road to a host rock waste stock pile (HRWS), located about 0.75 miles from the mine site. At the HRWS, waste rock, magnetite ore, and host rock would be stockpiled. The project site, including the mine, concentrator facility, and HRWS, is located about 11 miles east and slightly north of Hamilton, Montana, on U.S. Forest Service (USFS) lands in the Bitterroot National Forest (Figure S-1). Access to the site is provided from a Ravalli County highway via a private road and USFS roads. The project is a venture of Stansbury Holdings Corporation, conducting business as Western Vermiculite Company.

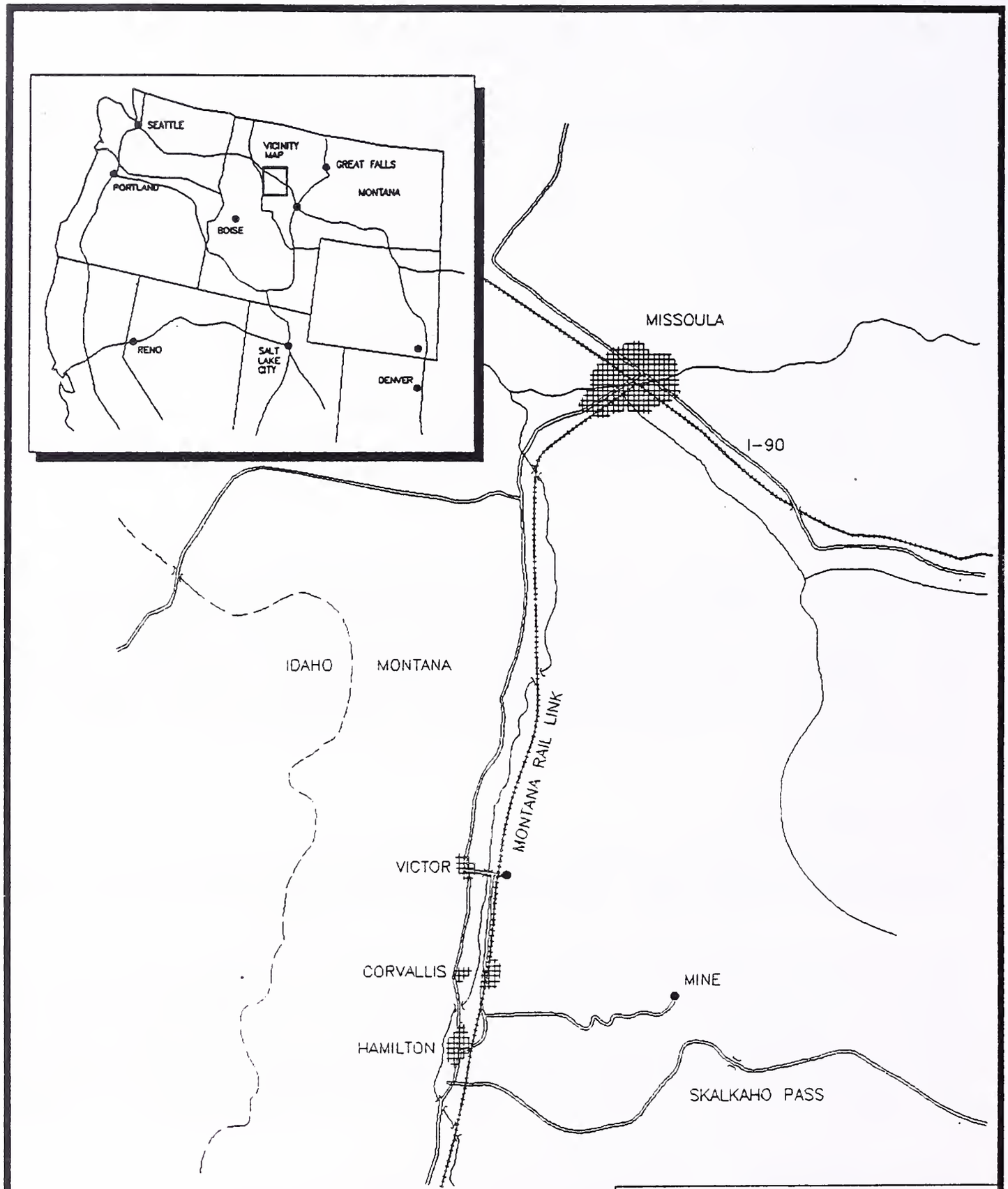
PURPOSE AND NEED

The purpose of the proposal is to allow the commercial mining and concentrating of vermiculite ore by a private entity (Stansbury Holdings Corporation), pursuant to their rights under mining laws, and the authorities of the U.S. Forest Service and Montana Department of State Lands.

The Environmental Impact Statement (EIS) will disclose environmental impacts under the National Environmental Policy Act (NEPA) and Montana Environmental Policy Act (MEPA) regulations and guidelines. This will provide information that the Montana Department of State Lands (DSL) and U.S. Forest Service (USFS) Bitterroot National Forest (BNF) will use to make final permitting decisions concerning the Operating Permit (DSL, No. 00094) and Plan of Operations (USFS) application, currently under review by the agencies. The agency responsibilities are also described more fully in the sections which follow.

SCOPE OF THE EIS

The scope of this draft EIS is the analysis of direct, indirect, and cumulative impacts from mining of vermiculite ore, concentration of that ore at a facility adjacent to the mine site, and storage of waste rock at a stockpile site about 0.75 miles from the mine site. Each of these activities would occur on lands within the BNF. Three alternatives evaluated in this draft EIS include the proposed action (Alternative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MISSOULA
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IDAHO
MONTANA
MONTANA RAIL LINK
VICTOR
CORVALLIS
MINE
HAMILTON
SKALKAHO PASS
0
18
SCALE
MILES
SOURCE: ADAPTED FROM STANSBURY HOLDINGS, 1990 a.
STANSBURY MINING EIS
PROJECT LOCATION
CAMP DRESSER & McKEE INC.
CDM
FIGURE
S-1

1), modification to the proposed action (Alternative 2), and no action (Alternative 3). In addition, this draft EIS considers several similar, cumulative, and connected actions. These actions include mineral claims in the vicinity of the proposed mine site, timber sales, a proposed wilderness area, and an exfoliation plant to be built in Butte.

EIS AND PERMITTING PROCESS

An EIS is a public document which is intended to disclose the environmental consequences of the proposed action and selected alternatives to that action. An EIS is required where proposed action by Montana or a Federal agency may "significantly affect the quality of the human environment," according to the requirements of the National Environmental Policy Act (NEPA), and the Montana Environmental Policy Act (MEPA).

Two governmental agencies serve as lead agencies for this EIS: the Montana Department of State Lands (DSL) and the U.S. Forest Service, Bitterroot National Forest. Other agencies who have supplied technical comments during the preparation of the EIS include the Montana Department of Natural Resources and Conservation (DNRC), Army Corps of Engineers, U.S. Fish and Wildlife Service, and Montana Department of Health and Environmental Sciences (DHES).

The Draft Environmental Impact Statement describes the environmental resources and communities which may potentially be affected by development and operation of an open pit vermiculite mine. The analysis of impacts on these resources is a major function of this EIS. The required USFS action is to make a determination regarding the Plan of Operations submitted for the project. The required Montana Department of State Lands action is to approve, approve with modifications, or disapprove the Amendment to Operating Permit No. 00094.

DEVELOPMENT OF ALTERNATIVES

According to the requirements of MEPA and NEPA, the agencies are required to consider the environmental impacts of a proposed action and of reasonable alternatives to this action. The "proposed action" in this case is construction, operation, and reclamation of the Western Vermiculite Project as proposed by Stansbury Holdings Corporation. The "No Action" alternative, in which the project would not be constructed and operated, must also be considered.

For this EIS, an additional alternative was developed (Alternative 2) which consists of reasonable modifications to various elements of the Stansbury proposal. The modifications were developed after a scoping process which included several meetings with agency technical experts and the public (Section 1.7). The modifications are based on the identification by the agencies and the public of potential adverse effects associated with the Stansbury proposal. One or more indicator parameters are selected for each environmental issue to help evaluate potential impacts and develop mitigations for each issue. An indicator parameter is a specific measure of environmental effects caused by a proposed action. These effects may have the potential to be severe, long-lasting, affect a large area, and/or have cumulative impacts when combined with likely future activities in the project area. The seven potential key environmental issues related to the proposed action are described as follows:

ISSUE 1 - WILDLIFE IMPACTS

The proposed mine project is located in an area with substantial elk activity. Although the elk herd is presently healthy and stable, there are concerns that increases in human activity associated with mine development and operation would displace elk from current calving and forage areas. Additional access from both the Stansbury project and other possible future development activities in the area may increase pressure on wildlife in the area. For these reasons, various mitigation measures are proposed in Alternative 2 to mitigate wildlife impacts. **Elk displacement and changes to the elk migration corridor**, as a result of the project, are selected as the indicator parameters for wildlife impacts.

ISSUE 2 - WATER QUALITY AND SEDIMENTATION

The mine is located in close proximity to the headwaters of St. Clair Creek (Figure S-2). The host rock waste stockpile (HRWS) is situated in a saddle between the St. Clair and Butterfly Creek drainages. Potential for increased runoff and sediment transport from these areas and project roadways to the St. Clair Creek drainage is a concern. Such increased sediment may have adverse impacts on the aquatic ecology of St. Clair Creek. The ABM Ridge deposit contains vermiculite and several amphibole minerals. The indicator parameters for water quality and sedimentation are **amphibole fibers and total suspended solids in water**.

ISSUE 3 - GROUND WATER AVAILABILITY, LEVELS, AND FLOW

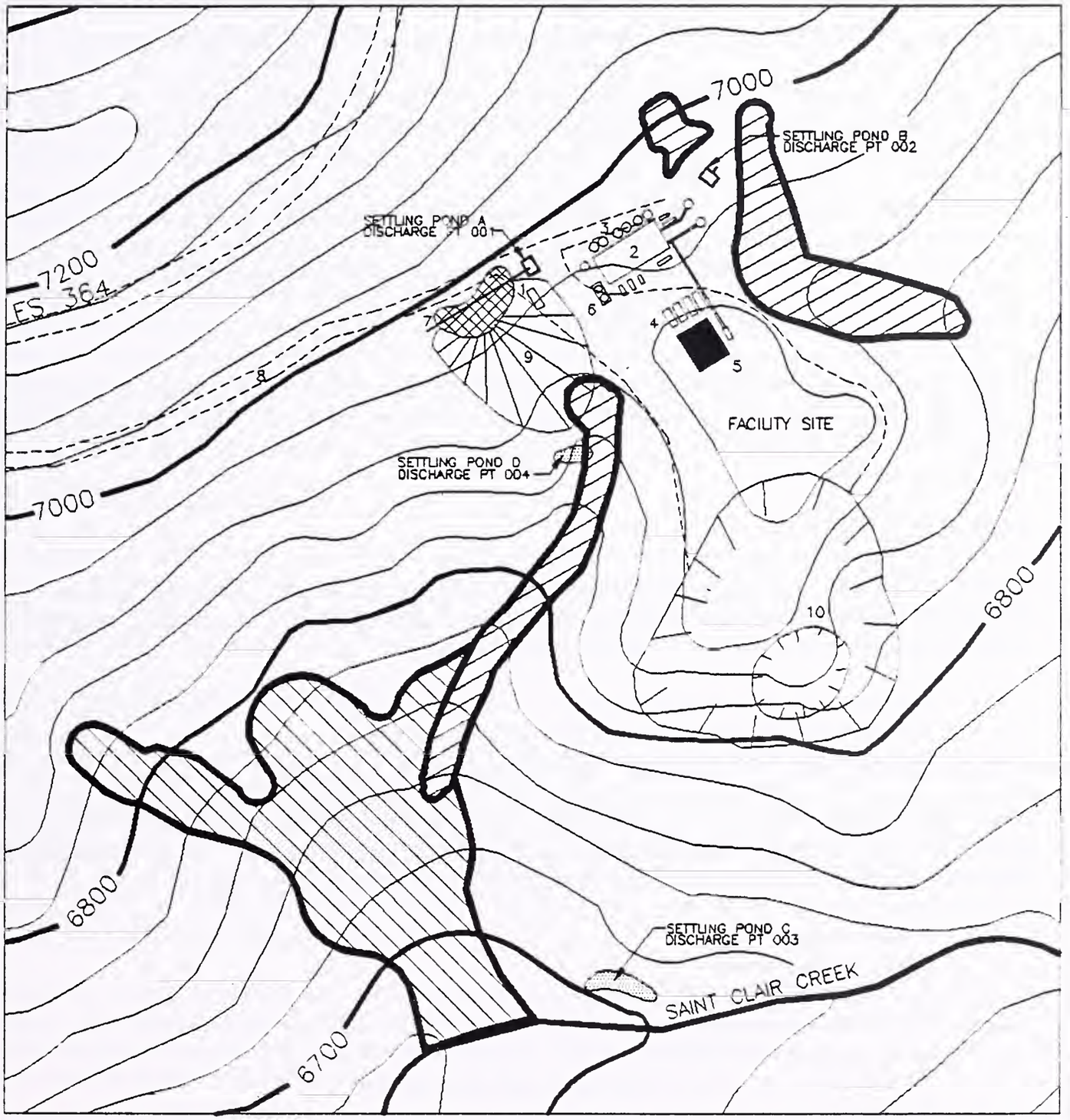
Ground water is present at both the mine site and the HRWS area. At the mine site, potential dewatering of the local bedrock ground water system would alter the water flow and distribution patterns at the project site. The design and implementation of plans to estimate the quantity of water expected during mining, to determine how this water would be handled, and to evaluate potential dewatering effects on local perennial streams, springs, and wetlands are a concern. Measurements for **ground water levels, flow, and quality at springs, seeps, and in the mine pit** (gallons/min, milligrams sediment/liter, etc.) are selected as the indicator parameters.

ISSUE 4 - WATER USE

Stansbury has applied for a water right permit to develop Prospect Spring, located within the project area, to supply water for road dust abatement and other project uses. The complexity of this water right issue may result in a water rights permit denial. To obtain water for the project, Stansbury would then have to drill a well on-site or transport water by truck to the mine. Each of these possible scenarios would require some mitigation. **Water supply and related water rights issues** are the indicator parameters selected for this issue.

ISSUE 5 - LOSS OF WETLANDS

Several small wetland areas are located in the mine site area (Figure S-2). Stansbury's proposal may result in partial or complete loss of these wetlands as a result of filling and/or dewatering. A series of complementary actions are identified in the impacts discussion (Sections 4.5 and 4.9) which would either avoid or mitigate loss of these wetland areas. **The net number of acres of lost wetlands** is the indicator parameter selected for this issue.



LEGEND

WETLANDS CLOSELY ASSOCIATED WITH ABM RIDGE & POSSIBLE HYDROLOGICALLY TIED TO ABM

WETLANDS OF SLOPES ADJACENT TO ABM RIDGE & NOT LIKELY HYDROLOGICALLY TIED TO ABM

1 – OFFICE AND PARKING
2 – CONCENTRATOR
3 – LOADOUT BINS
4 – WAREHOUSE, TOOLROOM AND OFFICE TRAILERS
5 – VEHICLE MAINTENANCE AREA
6 – FUEL OIL STORAGE
7 – TOPSOIL STOCKPILE
8 – ACCESS/CONCENTRATE HAUL ROAD
9 – FILL
10 – MINE PIT

SCALE: 1" = 300'

SOURCE: STANSBURY HOLDINGS, 1990 a & b.

STANSBURY MINING EIS

PROPOSED FACILITIES PLAN AND WETLANDS AREAS OF INTEREST

CAMP DRESSER & McKEE INC.

CDM

FIGURE S-2

ISSUE 6 - POTENTIAL INCREASED HEALTH RISKS FROM ACTINOLITE FIBERS

Community concern has been expressed regarding potential human health risks from the amphibole mineral antinolite, which is present in this vermiculite ore deposit. There exists a form of actinolite which is mineralogically related to asbestos; asbestos fiber is a known human carcinogen. However, the form of actinolite present in the ABM Ridge ore deposit generally does not appear to be asbestos-like. A health risk assessment was undertaken to evaluate potential health risks from exposure to amphibole minerals present in the ABM Ridge ore deposit. The indicator parameter used to evaluate potential health risks is the **quantitative estimate of increased cancer risks due to project operation.**

ISSUE 7 - TRANSPORTATION IMPACTS

The transportation of concentrates to the exfoliation plant in Butte causes concern regarding traffic safety, wildlife disturbance, increased noise and dust, possible reduction in real estate values, and additional road maintenance. The indicator parameter is the **number of vehicles of various types and weights on the haul road each day.**

ALTERNATIVES

As a result of careful deliberation by the agencies, it was determined that an additional alternative could incorporate Stansbury's proposal, with modifications, to address the issues raised above. Therefore, the three alternatives to be addressed in this EIS are as follows:

- Alternative 1 - Stansbury's proposal
- Alternative 2 - Stansbury's proposal with modifications
- Alternative 3 - No Action alternative

A number of other alternatives or modifications to Stansbury's proposal were considered but dismissed in the EIS. Various reasons for dismissal concerned technical, engineering, and economic considerations. The components of the project for which alternatives were considered included:

- Mining methods
- Concentrating methods
- Host rock waste stockpile locations
- Water use and management
- Transportation haul routes
- Infrastructure, including power supply and other utilities
- Reclamation
- Operational monitoring

ALTERNATIVE 1 - STANSBURY'S PROPOSAL

Stansbury's proposal would require disturbance of approximately 77 acres of the 139-acre permitted area addressed in this amendment to the Operating Permit. Major areas of disturbance include the facility site on ABM Ridge, the HRWS, widening of existing haul roads, and construction of a new road. An open pit mine would be developed for extraction of the vermiculite ore. The waste rock and host rock would be hauled approximately 0.75 miles from the mining pit to the HRWS. Also, magnetite ore encountered during mining operations would be stockpiled at the HRWS.

The mining project would operate annually during a six month period from May to October, when access to the site would be feasible. Initial construction is expected to occur over one six-month construction season, after all necessary permits and approvals are obtained. The project would then operate for an approximate five to eight year mine life, based on current estimated reserves. The project would employ up to 60 persons in mining and related operations, professional and administrative positions, and concentrate and waste rock haulage.

ALTERNATIVE 2 - STANSBURY'S PROPOSAL WITH MODIFICATIONS

Alternative 2 incorporates several potential modifications to Stansbury's proposal which would help mitigate impacts identified for many of the major issues previously discussed. Potential modifications include road closures and bussing of employees to address wildlife impacts, specific measures to improve roads and control dust and noise, increased control and management of surface water quality, and measures to address potential loss of wetlands due to decreased ground water flow. In addition, an alternate water use scenario is proposed which would not be dependent upon obtaining surface water rights for the project.

NO ACTION ALTERNATIVE

As required by MEPA and NEPA, the No Action alternative is also assessed in view of Alternatives 1 and 2. Under this alternative, Stansbury would not develop the Western Vermiculite Project. A reclamation bond for past mining operations, which is presently held by DSL, would be used for reclamation of existing disturbances under the No Action alternative.

THE AFFECTED ENVIRONMENT

The permit area addressed under this amendment to Operating Permit No. 00094 includes approximately 139 acres in the BNF (77 acres disturbed). A portion of the permit area is comprised of unreclaimed land disturbed by previous mining activities. Elevations for the mine site and vicinity range from about 6,600 to 7,200 feet. Most of the surrounding area is forested. St. Clair Creek is the major drainage, lying about 200 feet in elevation below the lower limit of mine disturbance. Two tributaries to the upper reaches of St. Clair Creek drain the project site. Wetlands are present to the east and southwest of the facility site. Ground water is present at the site.

Timber harvesting, recreation, and wildlife habitat are the predominant land uses in the vicinity of the project. Past mining operations at the project site are documented in the EIS, and remnants of these historic operations and structures are evident at the site. The proposed mining activity is compatible with uses identified in the BNF Forest Plan.

CONSEQUENCES OF THE PROPOSED ACTION AND ALTERNATIVES

As it is currently proposed, the Western Vermiculite Project could result in impacts in several of the key areas previously mentioned, including wildlife, ground water, wetlands, water use, aquatics, and transportation. Analyses performed as part of this EIS indicate that adverse health impacts from the Western Vermiculite Project are unlikely. The following section summarizes how the major issues could be affected by the implementation of each alternative.

Wildlife Impacts

Alternative 1 could cause minor disturbance to big game wildlife in the project vicinity because the project site is used by elk as calving and forage areas in the spring and summer, and as a migration corridor. Impacts to elk movement under Alternative 1 would likely cause about one-quarter mile displacement of the migration corridor to the south of the mine area.

Under Alternative 2, several measures are identified which would mitigate impacts to elk movement and migration, and minimize displacement of elk from the project area. A road closure program to control vehicular access to the ABM Ridge and the surrounding area during hunting season and during calving and migration periods would enhance the area for elk. Scheduling the operation of the mine between May 15 and October 15 would reduce the impact to elk on the winter range on the haul road down toward the Bitterroot Valley. Vehicular activity during the mining operations would be reduced by bussing workers to and from the mine site.

Alternative 3, the No Action alterative, would allow continued use of the mine site and project vicinity by big game and small mammals, but would cause temporary displacement of big game use patterns during reclamation. Reclamation of the site would increase wildlife habitat to the same extent as, but sooner than, Alternative 1.

Water Quality and Sedimentation Impacts

Diverse macroinvertebrate communities exist in the upper reaches of St. Clair Creek near the mine site, but apparently few fish exist there at the present time. A limited fishery in lower St. Clair Creek contains Westslope cutthroat and bull trout, which are State and Forest species of concern. Under Alternative 1, St. Clair Creek could be adversely impacted by changes in water quality and sedimentation. Mining-related activities such as road building, construction of the facility pad and construction and development of the mine pit, as well as construction of the HRWS haul road and the HRWS itself, may cause increased erosion and sedimentation in the project vicinity.

Alternative 2 outlines some changes to the sediment control plan. It also expands monitoring of water quality in St. Clair Creek. If results of this monitoring program indicate adverse impacts to St. Clair Creek water quality are occurring, Stansbury would meet with the appropriate State and Federal agencies to develop more modifications to the surface water control system.

Under Alternative 3, the mine would not be developed. Sediment yield to St. Clair Creek would be expected to decrease after reclamation of past mining disturbance.

Ground Water Impacts

Recent ground water monitoring in the project vicinity indicates that shallow ground water is present along ABM Ridge. It is expected that the mine pit will receive ground water inflows. The quality and quantity of these inflows are currently unknown. Mining activity might upset the hydrologic balance in the ABM Ridge project area, potentially dewatering springs and wetlands in the project vicinity.

Under Alternative 2, it is assumed that ground water will be encountered in the mine pit and will need to be properly handled within the mine operation hydrologic budget. Water quality monitoring would be required and limitations on disposal of water may be required. Alternative 2 would provide for additional monitoring of ground water flow at springs, seeps, and in the mine pit to determine hydraulic

and quality parameters. Potential impacts to wetlands would be mitigated through either recharge or replacement of the wetlands.

Under Alternative 3, the current hydrologic balance of the project area would be maintained.

Water Use Impacts

Alternative 1 proposes that Prospect Spring, located about 0.75 miles east of the mine site, could be developed to supply about 50 gallons per minute, or 30,000 gallons per day at a 10 hour per day rate, for project uses such as dust control, equipment washdown and maintenance, concentrator uses, and other uses at the facility site. Alternative 1 raises questions about existing surface water rights in the vicinity. Although Stansbury has applied to the DNRC for water rights to the spring, such rights have not yet been approved. Due to the complexity of the water rights situation in the Bitterroot Valley, Stansbury is expected to have difficulty obtaining water rights to supply project operations from Prospect Spring.

Alternative 2 proposes that either (a) a series of wells would be drilled on ABM Ridge to supply water for project use or (b) water would be trucked to the site. Any ground water wells drilled would need to be closely monitored and an evaluation of any potential impacts to wetlands, surface water and ground water of ABM Ridge and St. Clair Creek drainage, would need to be made.

Wetlands Impacts

Wetlands are present immediately to the east and southwest of the project site. Wetlands offer forage for elk and contain diverse plant communities. Effects of mine operations on the local hydrologic budget may affect wetlands. These sensitive ecologic areas are believed to be maintained by shallow subsurface flows along ABM Ridge and adjacent areas. Disruption of these systems could cause loss of all or part of this wetland acreage, which currently totals approximately 10 acres.

Under Alternative 2, careful monitoring of springs and seeps in the project vicinity, and of the condition of wetlands during project operations, would be maintained by the operator. Several modifications to the mine plan are proposed to minimize loss and/or degradation of wetlands. The goal of such activities would be to maintain wetlands in their current state, if possible. If wetlands are lost due to project operations, Federal agency policy is to replace lost wetland acreage either in the project vicinity or elsewhere.

Under Alternative 3, existing wetlands and the existing hydrologic budget of upper ABM Ridge would be unchanged.

Human Health Impacts

A Health Risk Assessment (HRA) was performed to evaluate potential health risks from amphibole minerals present in the ABM Ridge ore deposit under Alternative 1. The results of the HRA indicate that health risks estimates are negligible (less than one in a million excess cancer risks) for all exposure scenarios and conditions considered. Furthermore, because the assumptions used in this HRA were intentionally conservative or protective, it is likely that even these potential health risks are overestimated rather than underestimated. In particular, the assumption that nonasbestiform actinolite would cause the same adverse health effects as asbestos is an extremely conservative assumption. The conclusion of the HRA is that potential health risks from actinolite in the ABM Ridge ore deposit are extremely remote.

Transportation Impacts

Increased traffic due to the proposal would impact the route moderately. The proposed route from the mine site to the Hamilton Heights Road would require increased maintenance; Stansbury has committed to reconstruction and maintenance of the gravel road from the mine and concentrator, and to agreements with the owner of the private road through Charleys Gulch. Hamilton Heights Road and East Side Highway would require increased maintenance by Ravalli County.

Traffic would increase on the proposed haul route, especially during shift changes. Some Ravalli residents may be inconvenienced. Auto emissions and noise would increase, but there would be no major impact due to the environment's ability to assimilate and disperse dust and vehicle emissions given this traffic level and Stansbury's commitment to dust abatement.

Alternative 2 proposes bussing of employees to reduce traffic and its adverse dust, noise, and wildlife impacts.

COMPARISON OF ALTERNATIVES

The Western Vermiculite Project as proposed by Stansbury could have potential impacts regarding seven major issues. These issues were previously described.

Table S-1 summarizes the major issues as they are affected by the implementation of each alternative. This table will allow the reader and decision-maker to more effectively assess impacts of the various alternatives against the key environmental issues.

TABLE S-1

SUMMARY OF IMPACTS BY KEY ENVIRONMENTAL ISSUES

Key Environmental Issues	Alternative 1 Stansbury Project Plan	Alternative 2 Stansbury Project Plan with Mitigation Measures	Alternative 3 No Action
Water Quality and Sedimentation	Project development with designated sediment control measures and limited monitoring.	Project development with expanded monitoring program. Improved surface water control measures, including inwardly draining mine pits and enlarged sediment ponds.	No project; no additional activities to manage surface waters; some runoff and sedimentation continues from past mining and timber harvests in region until reclamation.
Wildlife Impacts	Project development with increased traffic and employee access; decreased elk security; improved habitat with reclamation.	Road closures and bussing of workers to increase elk security.	No project; reclamation project will improve elk habitat and security.
Water Use	Proposed project plan assumes development of spring to yield 50 gpm, or 30,000 gal/day; potential adverse impacts to downstream users.	Development of on-site wells, provision for delivery of water from off-site via trucks, or purchase of surface water rights.	No project; no water development would occur.
Ground Water Availability, Levels, and Flow	Proposed plan does not contain ground water management program to address excess ground water in mine pit and possible dewatering of ABM Ridge, potentially causing wetlands impacts, slope instability, and surface water quality impacts.	Address ground water/surface water impacts from mine pit development through improved control measures during construction and operation, additional data collection and analysis, and monitoring.	No project; no ground water discharge problems experienced because mine pit is not excavated to level of current ground water flow.
Loss of Wetlands	Loss of wetlands experienced through filling and dewatering as a result of mine-related construction.	Proposed plan with mitigation would address wetlands issues through: (a) relocation of soils stockpiles, (b) modification of sediment ponds, (c) replacement of lost wetlands,if necessary (d) elimination of road widening in wetlands areas, and, (e) relocation of mine buildings and facilities out of wetland areas.	No project; wetlands would remain in their present condition.
Public Health Risks	With proposed project development, health risks are estimated to be negligible.	No mitigation considered necessary.	No project; health risks from project would not occur
Transportation Impacts	Road improvements and maintenance would be performed as necessary.	Specified road improvements, maintenance, bussing and construction requirements would lessen impacts from dust, noise; and traffic safety would be improved.	Current limited use can be accommodated on existing roads if project is not constructed.

1.0 PURPOSE AND NEED

1.1 PROPOSED ACTION

Stansbury Holdings Corporation (Stansbury), doing business as Western Vermiculite Company, proposes to mine, concentrate, and transport vermiculite ore from May to October each year for an estimated project life of five to eight years. The mine is located on ABM Ridge, in the St. Clair Creek drainage of the Sapphire Mountains, about 11 miles east of Hamilton, Montana (Figure 1.1-1). The concentrating facility at the mine site would process approximately 400,000 tons of ore yearly (or about 2,700 tons per day over a 150-day annual operating cycle), producing about 30,000 tons of vermiculite concentrates. Up to 192,000 tons of in-pit waste also would be mined yearly.

An exfoliation and value-added products plant (not part of this permit) is planned to be constructed for processing the vermiculite concentrates. This plant would be located west of Butte, Montana in an industrial park in the SW1/4 of Section 24, T3N, R9W, south of the Port of Butte rail facilities on the Silver Bow siding. The exfoliation plant, operating year round, would produce marketable finished products. The vermiculite concentrates would be transported approximately 188 miles to this site in covered trucks during the six month annual operating schedule of the mine. About 15 trucks (18-ton capacity) would haul vermiculite concentrates from the mine/concentrator site to Butte daily.

The construction phase of the mine and concentrator is estimated at 28 weeks, and the exfoliation plant at 35 weeks. Construction would begin after all necessary plans and permits have been approved by various State and Federal agencies.

1.2 PURPOSE AND NEED

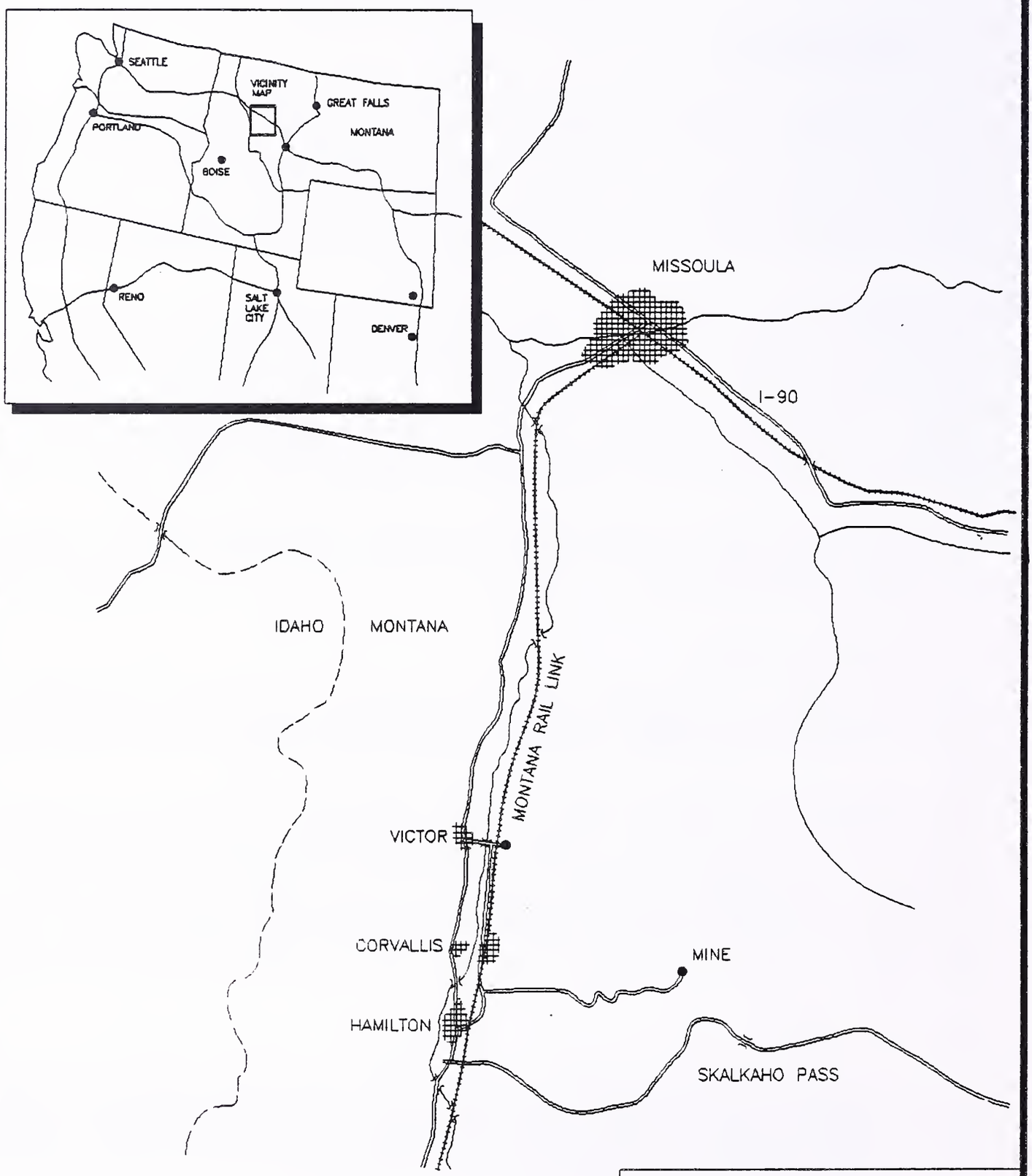
The purpose of the proposal is to allow the commercial mining and concentrating of vermiculite ore by a private entity (Stansbury Holdings Corporation), pursuant to their rights under mining laws, and the authorities of the U.S. Forest Service and Montana Department of State Lands.

The Environmental Impact Statement (EIS) will disclose environmental impacts under the National Environmental Policy Act (NEPA) and Montana Environmental Policy Act (MEPA) regulations and guidelines. This will provide information that the Montana Department of State Lands (DSL) and U.S. Forest Service (USFS) Bitterroot National Forest (BNF) will use to make final permitting decisions concerning the Operating Permit (DSL, No. 00094) and Plan of Operations (USFS) application, currently under review by the agencies. The agency responsibilities are also described more fully in the sections which follow.

NEPA AND MEPA

Procedures governing the Environmental Impact Statement (EIS) analysis process for State and Federal actions are defined in administrative rules implementing the National Environmental Policy Act (NEPA) and the Montana Environmental Policy Act (MEPA). This draft EIS was written to meet the requirements of these statutes and the administrative rules implementing these laws.

These laws require that if any action taken by the State of Montana or the USFS may "significantly affect the quality of the human environment," an EIS must be prepared. The EIS process involves several steps. Scoping activities are undertaken first to identify concerns and issues to be addressed in the EIS. A draft EIS is then assembled. A series of alternatives which include the proposed action and reasonable



SOURCE: ADAPTED FROM STANSBURY HOLDINGS, 1990 a.

STANSBURY MINING EIS

PROJECT LOCATION

CAMP DRESSER & McKEE INC.

CDM

FIGURE 1.1-1

alternatives to the proposed action are outlined. Reasons for dismissal of other alternatives are given. The environmental components which could be affected by the alternatives are identified and described in detail. An analysis of the consequences (impacts) of the alternatives is conducted. After publication of a draft EIS, a formal public review and comment period occurs, during which written and oral comments and questions regarding analysis of the project are solicited. A public meeting is held during this comment period to provide additional opportunity for public participation.

In the final EIS, substantive public comments and questions are considered and addressed. In addition, the alternatives previously considered may be modified, new alternatives may be evaluated, additional information on the proposed action might be requested, or further analysis of existing alternatives may be considered. Each agency must issue a Record of Decision (ROD) documenting the decision made and the reason for the decision. The purpose of a Record of Decision is to describe and document the actions taken by each agency's decision maker or decision-making body.

1.3 SCOPE OF THE EIS

The scope of this EIS includes the analysis of the direct, indirect, and cumulative impacts from mining of vermiculite ore, concentration of that ore at the mine site, and storage of waste rock at a stockpile site about 0.75 miles from the mine site. Each of these activities would occur on lands within the Bitterroot National Forest. A Health Risk Assessment (HRA) is also a component of this analysis. In addition, this EIS considers several similar, cumulative, and connected actions.

The Council on Environmental Quality (CEQ) regulations implementing NEPA require that Federal agencies consider three types of actions to determine the scope of an EIS: 1) **connected actions**, which are two or more proposed actions that are dependent on each other for their utility; 2) **cumulative actions**, "which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement"; and 3) **similar actions**, "which when viewed with other reasonably foreseeable or proposed actions have similarities that provide a basis for evaluating their environmental consequences together." (40 CFR 1508.25(a)). The similar, cumulative, and connected actions considered within the scope of this EIS are described below.

MINERAL EXPLORATION AND DEVELOPMENT

Existing patented and unpatented mining claims in the project vicinity may indicate potential mineral development activity in future years. Records of the USFS in Missoula and U.S. Bureau of Land Management in Billings were consulted to determine numbers of recorded claims in the area (about 138,000 acres) surrounding the mine site. The results are presented in Table 1.3-1 and Figure 1.3-1. No other plans of operations currently are filed for the claims in Table 1.3-1. This area includes 162 recorded claims, 134 of which belong to Western Vermiculite Company. The proposed mining site is located on ABM Ridge. Potential reserves have been identified on nearby Horse Ridge but have not been fully explored. Table 1.3-2 further details lands in the vicinity of the proposed mine site which are potentially withdrawn from mineral entry, subject to pre-existing rights. The magnitude of these cumulative impacts on area resources would depend on the rate and timing of mine development.

STONY MOUNTAIN RECOMMENDED WILDERNESS AREA

The Stony Mountain Area encompasses 101,500 acres of Roadless Area, including 68,430 acres of Recommended Wilderness Area, which is generally inclusive of the Skalkaho Game Preserve (see Figure 1.3-1). The proposed mine site is located less than one mile outside of the southern part of the Stony

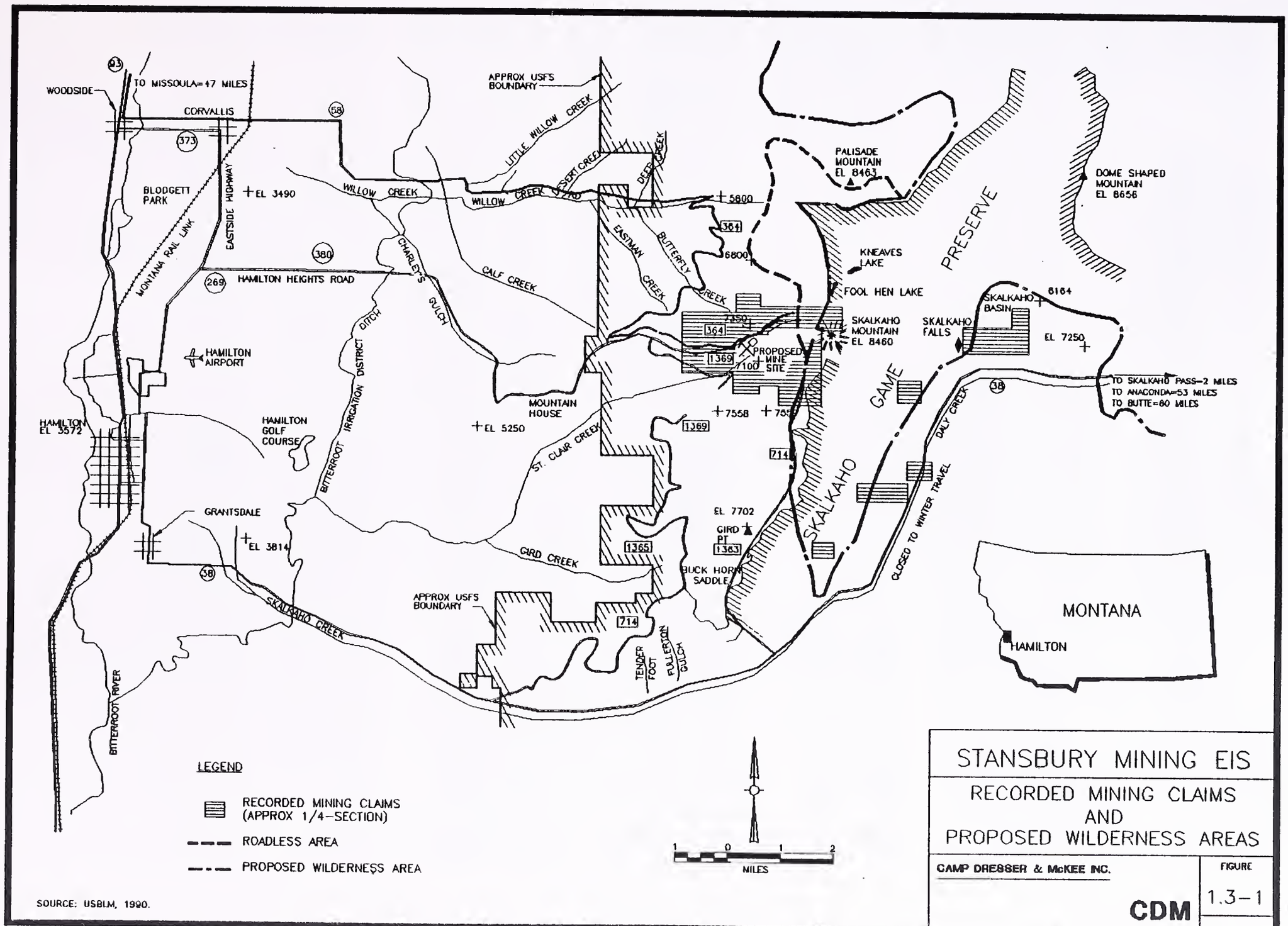
TABLE 1.3-1

RECORDED MINING CLAIMS
STANSBURY WESTERN VERMICULITE PROJECT VICINITY

Township and Range	Section	Number of Recorded Claims
T5N, R18W	3	4
	4	1
	8	1
	27	2
	34	11
T6N, R18W	19	29* [1]
	20	16*
	23	2*
	24	13* [+]
	27	1
	29	8
	30	19*
T6N, R19W	23	4*
	34	13*
	25	29*
	26	9*

Source: U.S. Bureau of Land Management, 1990.

* All Western Vermiculite; proposed existing Plan of Operations includes only a portion of these claims.
[+] ABM Ridge
[1] Horse Ridge



SOURCE: USBLM, 1990.

STANSBURY MINING EIS

RECORDED MINING CLAIMS AND PROPOSED WILDERNESS AREAS

CAMP DRESSER & McKEE INC.

CDM

FIGURE 1.3-1

TABLE 1.3-2

LANDS POTENTIALLY WITHDRAWN FROM MINERAL ENTRY
STANSBURY WESTERN VERMICULITE PROJECT VICINITY

Township and Range	Section Numbers and Description
T5N, R18W	Sec 25 Sec 34* Sapphires (Congressionally-designated) Wilderness Study Area Sec 1, 4*, 9, 16, 22, 25, 26, 27*
T4N, R19W	Sec 4 Sec 35
T5N, R20W	Sec 34 Sec 35
T6N, R18W	Sec 17 Sec 34 Sapphires Wilderness Study Act Sec 24*, 25, 27*, 34
T6N, R19W	Sec 14 Sec 35

Source: U.S. Bureau of Land Management, 1990.

* Recorded mining claims exist in portions of these sections.

Note: Also, on private lands within T6N, R20W, other rights exist which restrict access.

Mountain Area. The Stony Mountain Area, which includes habitat for elk, deer, moose, bear, and mountain goat, attracts hunters and wildlife enthusiasts. If this area were to be designated as a wilderness area, Stansbury Holdings Corporation would have pre-existing rights for their mineral claims if the claims are valid. In addition, because hunting is typically allowed in wilderness areas, increased hunting pressure on elk in the area is a potential impact of wilderness designation.

TIMBER SALES

Two timber sales are proposed in the general vicinity of the mine. Under the Calf Creek Timber Sale, located in the drainage immediately to the north of the proposed mine, approximately 1.2 million board feet (MMBF) would be harvested. Logging is projected to occur in June 1991, with completion in 1993. If this sale does not occur, no cumulative impacts would occur. However, if logging proceeds, the adverse effects on elk security are a potential cumulative impact. Road management would mitigate impacts on elk security that would result from timber and mining operations.

The other proposed sale is a fire salvage sale located in the Gird Creek drainage, approximately 5 miles to the south of the proposed mine. An estimated 5 MMBF will be offered for harvest this winter (1990) to retain the timber's value. If sold, logging would likely be completed by fall of 1991. The proposal does not have a cumulative major impact with the mine site, due to its distance from the mine site.

VERMICULITE EXFOLIATION PLANT

Stansbury Holdings Corporation's application includes plans to build a vermiculite exfoliation plant in Butte, Montana, to process the vermiculite ore from the ABM Ridge deposit. Potential health risks from plant operation and travel routes to the plant were evaluated for this EIS in the context of a connected action. Jurisdiction for exfoliation plant permits lies with other State and Federal agencies. Applications for the exfoliation plant have not been pursued by Stansbury at this time.

1.4 FOREST PLAN DIRECTION

Development of this Environmental Impact Statement follows implementing regulations of the National Forest Management Act (NFMA), Title 36; Code of Federal Regulations, Part 219 (36 CFR 219); Council on Environmental Quality, Title 40; Code of Federal Regulations, Parts 1500-1508 (40 CFR 1500-1508); NEPA, and is tiered to the Forest Plan Environmental Impact Statement (USFS, 1987a). This analysis incorporates direction provided in the Forest Plan EIS (USFS, 1987a), Record of Decision (USFS, 1987b), and Forest Plan (USFS, 1987c).

The Forest Plan, based on the various considerations addressed in the final Environmental Impact Statement (FEIS), guides all natural resource management activities and establishes standards for the Bitterroot National Forest. The Forest Plan delineates Management Areas (MA), which respond to Forest goals and objectives, and provide management standards to meet those goals and objectives.

The proposed action to mine the ABM Ridge ore deposit is within Management Area 1. The haul route traverses Management Area 2. Mining-related activities, including surface water and sediment control, soil stockpile, and facility construction are proposed in Management Area 3b. Finally, additional Stansbury mining claims are within Management Area 8a. The primary goals of these Management Areas are:

MA 1 - Emphasize timber management, livestock, and big game forage production, which provide an added benefit of access for roaded recreation activities and mineral exploration. Assure minimum levels of visual quality, old growth, and habitat for other wildlife species. (Forest Plan, pgs. III-3-8).

MA 2 - Optimize elk winter range habitat using timber and other vegetation management practices. Provide moderate levels of visual quality, old growth habitat, and livestock forage. (Forest Plan, pgs. III-9-14).

MA 3b - Manage riparian areas to maintain flora, fauna, water quality, and water-related activities. Emphasize water and soil protection, dispersed recreation use, visual quality, and old growth. Provide low levels of timber harvest, livestock forage, and big game forage on fisheries riparian areas, and moderate levels of timber harvest and forage on non-fisheries riparian areas. Roading in riparian areas will be restricted to meet water quality and fish objectives. (Forest Plan, pgs. III-22-29).

MA 8a - Manage at the minimum level for elk security, old growth, and habitat diversity; but protect timber, soil, water, recreation, range, and wildlife resources on adjacent management areas. (Forest Plan, pgs. III-58-60).

1.5 AGENCY RESPONSIBILITIES

For this project, two lead agencies have been designated. The USFS is the designated Federal lead agency because the project and its primary environmental impacts are located on the BNF. The lead State agency is the DSL because it is responsible for permitting locatable mineral operations in the State of Montana. A memorandum of understanding was signed by these agencies which states that these two agencies will cooperate to produce a joint EIS that meets requirements of NEPA, MEPA, Federal and State mining laws, and Federal and State agency policy with regard to land management plans.

BITTERROOT NATIONAL FOREST

Mining on National Forest Lands

The ore deposit, mine, and associated facilities of the proposed Western Vermiculite Project are on lands administered by the BNF. The Organic Administration Act authorizes the Secretary of Agriculture to regulate occupancy and use of National Forest lands for the protection and management of forest resources. Regulations for mining activities on National Forest lands are contained in 36 CFR Part 228, Subpart A. A proposed Plan of Operations must be submitted for activities that could result in significant disturbance to surface resources. This regulation requires that the applicant describe the proposed operation, environmental protection measures, and reclamation specifications.

Plan of Operations

Stansbury has submitted a proposed Plan of Operations to the BNF (Stansbury Holdings Corporation, 1990a). The Forest Supervisor of the BNF will issue a decision on Stansbury's proposal in a ROD (see Agency Decisions in this Section). Stansbury may appeal the decision pursuant to 36 CFR Parts 217 or 251. Other parties wishing to appeal the decision may do so in accordance with appeal procedures provided in 36 CFR Part 217.

Reclamation Bonding

The DSL will collect a bond from Stansbury to ensure that the lands involved with the mining operation are properly reclaimed. The BNF may require an additional bond if it determines that the bond held by DSL is not adequate to reclaim National Forest lands or would be administratively unavailable to meet Forest Service requirements.

Inspections and Monitoring

The BNF is responsible for monitoring and inspecting all projects on National Forest lands. USFS personnel would inspect the facility and monitor environmental impacts on a regular basis until operations are progressing smoothly, with periodic inspections thereafter. DSL also has monitoring responsibilities for the Western Vermiculite Project which are described in the next section.

MONTANA DEPARTMENT OF STATE LANDS

Operating Permit

The DSL administers the Montana Metal Mine Reclamation Act (Title 82, Chapter 4, Part 3, MCA), under which Stansbury has applied for an amendment to existing Permit No. 00094 (Stansbury Holdings Corporation, 1990a). The purpose of this law is to prevent land and surface water degradation by requiring lands disturbed by mining to be stabilized and reclaimed. The Metal Mine Reclamation Act (MMRA) requires an approved operating permit for all mining activities which disturb more than 5 acres or recover more than 36,500 tons of ore annually. The DSL must decide whether to approve or deny Stansbury's request for a permit amendment, and if approved, under what conditions. The Montana State Lands Commissioner may make a decision to approve Stansbury's permit application no sooner than 15 days following publication of the final EIS.

Reclamation Bonding

Before an operating permit can be issued, a reclamation performance bond must be posted with the DSL. The reclamation bond amount must be sufficient for the State to complete reclamation in case of default by the operator. Reclamation costs include roads, waste, and slope reclamation, and take into account volumes of material to be handled and Stansbury Holdings Corporation yearly monitoring activities. Costs are based on standards found in construction manuals, as well as administrative costs. Bonds for projects such as this typically range between $1,000 and $5,000 per acre.

Inspections and Monitoring

DSL would routinely conduct inspections of the Western Vermiculite Project to ensure compliance with approved plans. Monitoring data collected by Stansbury would be evaluated and coordinated with other State and Federal agencies. The DSL can issue notices of violation and levy civil penalties in enforcing its regulations.

AGENCY DECISIONS

Following conclusion of the comment period for the draft EIS, the agencies will address public comments, revise the draft EIS, if necessary, and prepare a final EIS. At that time, the agencies will

attempt to make a joint decision regarding Stansbury's permit request but are not legally required to do so. If a joint decision cannot be made, agencies may render separate permit decisions.

Agency Approval

Joint approval of the project by BNF and DSL would allow the project to proceed under conditions and restrictions contained in the selected alternative. Stansbury would likely be required to obtain all necessary permits and licenses described in Table 1.5-1 prior to construction and operation.

Federal Agency Permit Denial

No authority exists for the Forest Service to deny a Plan of Operations. However, a Plan of Operations must meet the purpose of the Forest Service locatable mineral regulations as described in 36 CFR 228 Subpart A. These regulations state in part that all operations shall be conducted so as, where feasible, to minimize adverse environmental impacts on National Forest surface resources, including complying with all applicable Federal and State air and water quality standards and standards for the disposal and treatment of solid wastes. Furthermore, all practicable measures must be taken to harmonize operations with scenic values and maintain and protect fisheries and wildlife habitat which may be affected by the operation.

State Agency Permit Denial

Grounds for DSL denial would be a finding that the mining or reclamation plan is not feasible, or the project would violate the laws of Montana, primarily the Metal Mine Reclamation Act, water and air quality laws.

1.6 OTHER PERMIT REQUIREMENTS, LICENSES AND APPROVALS

In addition to approvals by the lead agencies required for the Western Vermiculite Project, various other permits, licenses or approvals from other agencies would be necessary. A summary of the likely permits is presented in Table 1.5-1.

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

The Montana Department of Natural Resources and Conservation (DNRC) administers the Montana Water Use Act. Stansbury has applied for and will be required to obtain a water use permit prior to start of construction.

The Montana Water Use Act of 1973 established a permit system for the acquisition of a water right. If a developer does not have an existing water right, the law requires a water use permit before water can be put to beneficial use. Stansbury's surface water use during operations would be a beneficial use allowed by law. Since Stansbury does not have an existing permanent water right, Stansbury would be required to obtain water use permits for surface waters used in the construction or operation of the mine and ore concentrator. Based on the application for a mine operating permit submitted to the DSL, Stansbury would be required to obtain permits for the use of surface water for domestic purposes at the mine site, and for mine construction and operation. Surface water would be withdrawn from a spring at the mine site. Stansbury would be required to obtain necessary permits before construction begins.

TABLE 1.5-1

PERMITS, LICENSES, AND APPROVALS WHICH MAY BE REQUIRED
FOR THE STANSBURY WESTERN VERMICULITE PROJECT

Permit, License or Approval	Purpose
U.S. Forest Service (USFS)	
Approval of Plan of Operations (36 CFR 228 Subpart A)	To allow for mineral exploration and development on Forest System lands. Approval incorporates management requirements to minimize or eliminate effects on other forest resources. Approval is documented in a Record of Decision (ROD).
Road Use Permit	To specify operation and maintenance responsibilities on Forest System roads used for commercial hauling of ore concentrate.
Mineral Material Permit	To allow Stansbury to take borrow material from Forest System lands.
Timber Sale Contract	To allow Stansbury to harvest commercial timber from the project area within Forest System lands.
Cultural Resource Clearance	To obtain joint approval by the USFS and State Historic Preservation Office prior to construction activities.
Final Design Approval of Facilities	To ensure design consistency of plant site, conveyor system, host rock waste stockpile site, and access roads with preliminary plans. Coordinate with DSL and other appropriate agencies.
Montana Department of State Lands (DSL)	
Operating Permit (Montana Metal Mine Reclamation Act)	To allow mining development activity.
Department and Board of Health and Environmental Sciences	
--Air Quality Bureau--	
Air Quality Permit (Montana Clean Air Act)	To control particulate emissions of more than 25 tons per year.
--Water Quality Bureau--	
MPDES Permit (Montana Water Quality Act)	To control point sources issuing discharges into waters of the State.
Department and Board of Natural Resources and Conservation (DNRC)	
Water Rights Permit (Montana Water Use Act)	To allow beneficial use of State waters obtained through any surface water diversion; or through ground water withdrawal exceeding 100 gallons per minute.
Army Corps of Engineers	
404 Permit (Federal Clean Water Act)	To control discharge of dredged or fill material into waters of the United States or on wetlands - for modifications to upper tributaries of St. Clair Creek.
Bitterroot Conservation District	
310 Permit (Montana Natural Streambed and Land Preservation Act)	For direct disturbance of a waterway during project operations.

Source: Adapted from U.S. Forest Service/Montana Department of State Lands, 1990.

MONTANA DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES

Air Quality Bureau

The Air Quality Bureau administers the Montana Clean Air Act. Any proposed project having estimated pollutant emissions (without emissions controls) exceeding 25 tons per year must obtain an air quality permit. Stansbury has applied to the Air Quality Bureau for an air quality permit for the Western Vermiculite Project. The permit would specify air emissions limitations and monitoring requirements. Stansbury must apply Best Available Control Technology to each emissions source, and must demonstrate that the project would not violate Montana or Federal Ambient Air Quality Standards. The Air Quality Bureau would conduct periodic inspections to ensure permit compliance.

Air quality and other impacts of the exfoliation plant at Butte will be addressed under separate permitting activity by the appropriate agencies. However, potential health risks from amphibole fibers present in the vermiculite ore are evaluated in Appendix A - Health Risk Assessment. Potential health risks have been previously identified (Section 1.2) as a "connected" action under NEPA/MEPA regulations.

Water Quality Bureau

The Water Quality Bureau is responsible for administration of the Montana Water Quality Act. This law provides a framework for the classification of surface and ground water uses. It also establishes surface water quality standards as well as permit programs to control the discharge of pollutants into State waters. A Montana Pollutant Discharge Elimination System (MPDES) permit must be obtained before any discharge to surface water can occur.

U.S. ARMY CORPS OF ENGINEERS

Stansbury has submitted a "404 permit" application to the U.S. Army Corp of Engineers. If approved, the Corps of Engineers would issue a 404 permit (referring to Section 404 of the Clean Water Act) for construction of "dredge and fill" activities affecting "navigable" waters or wetlands. The 404 permit decision will be documented by the Corps of Engineers.

MINE SAFETY AND HEALTH ADMINISTRATION (MSHA)

MSHA has regulatory responsibility for occupational safety and health at the mine site. Their regulations pertain to construction and operations procedures, safety devices and equipment, personnel protective gear (e.g., hard hats, steel-toed boots, gloves, safety glasses, hearing protection, and dust masks), and safety plans and education. Periodic inspections provide enforcement of MSHA requirements; citations and corrective action may follow inspections which show that improper procedures are being followed to address worker health and safety. Additional details regarding MSHA are discussed in Sections 1.3 of the Health Risk Assessment (Appendix A).

1.7 PUBLIC PARTICIPATION

Public participation is a key element of any EIS. The first opportunity for public involvement occurs in the beginning of the EIS process, when "scoping" is conducted. The purpose of scoping is to compile a broad list of significant environmental issues related to the proposed action and to analyze them in depth. The subsequent analyses conducted in the EIS process focus on the significant issues identified. The scope of this EIS was established by this process.

The record of scoping and general public participation activities on this project has continued from 1987-1990. Highlights are as follows:

- During July-November 1987, five meetings were held in Hamilton and vicinity which involved BNF, DSL, Stansbury officials, and the public.

- During February-November 1988, seven additional meetings were held involving the same parties as above. Also during this period, Notices of Intent were published in the Federal Register regarding preparation of the EIS, reactivation of the project, and extension of the comment period.

- During June 1988, the issue of the Butte exfoliation plant was discussed with Butte citizens and BNF.

- Three meetings were held in 1990 to discuss health risks and reintroduce the project to area citizens.

- Extensive media coverage for the project has occurred throughout the EIS process. Two volumes of news clips have been compiled by the agencies during the past 3 years. A locally produced television special on the project and its impacts was also prepared and televised to area residents.

Many issues have been raised during the public scoping period. Table 1.7-1 lists the major issues, and shows where they have been addressed in the EIS. The issues are listed numerically, and the order in which they appear is not meant to imply any priority ranking or designation.

1.8 ORGANIZATION OF THE EIS

The remaining sections of the EIS will address the following:

- Chapter 2.0 describes, in much greater detail, the proposed action, alternatives to the proposed action, the no action alternative, and alternatives previously considered but dismissed, and summarizes comparison of impacts by alternative.

- Chapter 3.0 describes the affected environment, or baseline conditions prior to development, for various aspects of the environment (e.g., wildlife, water, air quality, and social economic conditions.

- Chapter 4.0 describes in detail the environmental impacts to each environmental sector from: the proposed action (Alternative 1), mitigations to the proposed action (Alternative 2), or No Action (Alternative 3). Section 2.6 summarizes these impacts for the reader and decisionmaker.

- Chapter 5.0 discusses the agency and public distribution of the EIS, and the qualifications of those who prepared it.

- Appendix A provides details regarding the assessment of public health risks of mining, hauling, and exfoliating the vermiculite ore from the project site. These risks are summarized in Section 4.4.

TABLE 1.7-1

PUBLIC SCOPING ISSUES

Issue	Section Number Where Addressed in the EIS
1. Health Risks: impacts from exposure to amphibole fibers from mining-related activities	3.4, 4.4
2. Air Quality: impacts of dust from hauling trucks and the stockpiles	3.2, 4.2
3. Water Quality: impacts of runoff and sedimentation to St. Clair Creek fish populations	3.5, 3.6, 4.5, 4.6
4. Traffic and Transportation: impacts of haul trucks, including noise, dust, road maintenance, interference with logging traffic, and air pollution; impacts of commuter traffic to and from the mine site, including congestion, air pollution, and property values	2.2, 2.3, 3.13, 3.14, 3.15, 4.13, 4.14, 4.15
5. Economics: impacts on employment, taxation, the business cycle, and economic expansion	3.13, 4.13
6. Reclamation: proposed plan of reclamation, including weed control plan	2.2, 2.3, 3.8, 3.9, 4.8, 4.9
7. Development of Claim Area: impacts of future development of other mining claims held by Stansbury	3.0, 3.15, 4.0-4.15
8. Stability of HRWS and Pit Walls	2.2, 2.3
9. Recreation: noise, visual, and geographic impacts on recreational use in the BNF, including hunting, wildlife viewing, hiking, cross-country skiing, and fishing	3.10, 3.11, 3.12, 4.10, 4.11, 4.12
10. Visual Resources: impacts on the aesthetic value of the environment in the vicinity of the proposed mine site and haul roads	3.10, 4.10
11. Traffic Safety: impact of increased traffic on roads	3.12, 4.12
12. Cultural Resources: impact of proposed mine site, haul roads, and HRWS on sites eligible for National Register of Historic Places (NRHP)	3.10, 4.10
13. Quality of Life: cumulative impact of proposed action on Ravalli residents' overall quality of life	2.6, 3.13, 4.13
14. Endangered Species: impacts on threatened and endangered plants and animals	3.7, 3.9, 4.7, 4.9

TABLE 1.7-1 (Cont'd.)

PUBLIC SCOPING ISSUES

Issue	Section Number Where Addressed in the EIS
15. Real Estate Values: impacts of increased traffic and congestion of haul road and commuter routes on adjoining land values	3.12, 3.13, 4.12, 4.13
16. Ground Water: impacts of mine pit on hydrologic budget, wetlands, springs and seeps	3.5, 4.5
17. Water Use: source of mine water supply; springs; ground water; water rights	3.5, 4.5
18. Loss of Wetlands: impacts on local and regional diversity	3.5, 3.9, 4.5, 4.6, 4.7, 4.8, 4.9
19. Sampling of Amphibole (Actinolite) Material: methods of sampling ore body for asbestiform minerals	3.3, Appendix A
20. MSHA Standards: requirements for mine site, mill, and concentrator	1.4, Appendix A
21. Concentrator Emissions: filtering and monitoring of emissions	4.2, 4.4, Appendix A
22. Amphibole (Actinolite) Dike: segregation and removal of dike material	2.2
23. Elk Population: impacts of the proposed action on elk, including habitat destruction, possible rerouting of migration corridors, interference with calving, herd restocking, and changes in population size	3.7, 4.7
24. Temporary Shutdowns of Mine and/or Concentrator: economic and social impacts	Unpredictable, therefore not directly addressed
25. MEPA and NEPA Requirements:	1.2
26. Responsible Parties	1.3, 1.4

2.0 PROPOSED ACTION AND ALTERNATIVES

This chapter summarizes the proposed action (the Western Vermiculite Project, an open-pit vermiculite mine and on-site concentrator) and reasonable alternatives to the proposed action, including the No Action alternative. The first section of this chapter, *Development of Alternatives and Key Project Issues*, describes how alternatives were developed for this EIS based upon the key issues defined in public scoping sessions and identified by the agencies (see Section 1.7). The next three sections (2.2, 2.3, and 2.4) describe *Stansbury's Proposal* (Alternative 1), *Stansbury's Proposal with Modifications* (Alternative 2), and the *No Action Alternative* (Alternative 3). Alternatives which were considered but not addressed in this EIS for technical and/or policy reasons are discussed in the next section (2.5), *Alternatives Considered but Dismissed*. Finally, the summary of impacts to key issues by alternative, often called the heart of the EIS, concludes Chapter 2.0 in the *Comparison of Alternatives* section (2.6).

2.1 DEVELOPMENT OF ALTERNATIVES AND KEY PROJECT ISSUES

In an EIS, the agencies are required to evaluate the environmental effects of the proposed action and reasonable alternatives to the proposed action. At a minimum, the draft EIS must consider the proposed action and the No Action alternative.

The proposed action for this EIS is that Stansbury would develop, operate, monitor, and reclaim the Western Vermiculite Project as proposed in the Amendment to Operating Permit No. 00094. Other agencies would issue additional permits and approvals. A summary of the Stansbury proposal is given in Chapter 1.0, and more details are given in Section 2.2 which follows.

Under the No Action alternative, Stansbury would not develop the Western Vermiculite Project. The No Action alternative (Section 2.4) provides a baseline for estimating the effects of other alternatives.

For this EIS, an additional alternative is developed (Section 2.3) which consists of reasonable modifications to various elements of the Stansbury proposal. The modifications were developed after a scoping process which included several meetings with agency technical experts and the public (Section 1.7). The modifications are intended to resolve or minimize impacts as identified by the agencies and the public having potentially significant adverse effects associated with the Stansbury proposal. An indicator parameter is selected for each environmental issue to help evaluate potential impacts and proposed mitigations for each issue. An indicator parameter is a specific measure of environmental effects caused by a proposed action. These effects have the potential to be severe or long-lasting, could affect a large area, and/or have cumulatively adverse impacts when combined with likely future activities in the project area. The seven potential key environmental issues related to the proposed action are described as follows:

ISSUE 1 - WILDLIFE IMPACTS

The proposed mine project is located in an area with substantial elk activity. Although the elk herd is presently healthy and stable, there are concerns that increases in human activity associated with mine development and operation would displace elk from current calving and forage areas. Additional access from both the Stansbury project and other possible future development activities in the area may increase pressure on wildlife in the area. For these reasons, various mitigation measures are proposed in Alternative 2 to mitigate wildlife impacts. **Elk displacement and changes to the elk migration corridor**, as a result of the project, are selected as the indicator parameters for wildlife impacts.

ISSUE 2 - WATER QUALITY AND SEDIMENTATION

The mine is located in close proximity to the headwaters of St. Clair Creek. The host rock waste stockpile (HRWS) is situated in a saddle between the St. Clair and Butterfly Creek drainages. The potential for increased runoff and sediment transport from these areas and project roadways to the St. Clair Creek drainage is a concern. The ABM Ridge deposit contains vermiculite and several amphibole minerals. The indicator parameters for water quality and sedimentation are **amphibole fibers and total suspended solids in water.**

ISSUE 3 - GROUND WATER AVAILABILITY, LEVELS, AND FLOW

Ground water is present at both the mine site and the HRWS area. At the mine site, dewatering of the local bedrock ground water system would alter the water flow and distribution patterns at the project site. The design and implementation of plans to estimate the quantity of water expected during mining, to determine how this water would be handled, and to evaluate potential dewatering effects on local perennial streams, springs, and wetlands are a concern. Measurements for **ground water levels, flow, and quality at springs, seeps, and in the mine pit** (gallons/min., milligrams sediment/liter, etc.) are selected as the indicator parameters.

ISSUE 4 - WATER USE

Stansbury has applied for a water right permit to develop Prospect Spring, located within the project area, to supply water for road dust abatement and other project uses. The complexity of this water right issue may result in a water rights permit denial. To obtain water for the project, Stansbury would then have to drill a well on-site or transport water by truck to the mine. Each of these possible scenarios would require some mitigation. **Water supply and related water rights issues** are the indicator parameters selected for this issue.

ISSUE 5 - LOSS OF WETLANDS

Several small wetland areas are located in the mine site area. Stansbury's proposal may result in partial or complete loss of these wetlands as a result of filling and/or dewatering. A series of complementary actions are identified in the impacts discussion (Section 4.5 and 4.9) which would either avoid or mitigate loss of these wetland areas. **The net number of acres of lost wetlands** is the indicator parameter selected for this issue.

ISSUE 6 - POTENTIAL INCREASED HEALTH RISKS FROM ACTINOLITE FIBERS

Community concern has been expressed regarding potential human health risks from the amphibole mineral actinolite, which is present in this vermiculite ore deposit. There exists a form of actinolite which is mineralogically related to asbestos; asbestos fiber is a known human carcinogen. However, the form of actinolite present in the ABM Ridge ore deposit generally does not appear to be asbestos-like. A health risk assessment was undertaken to evaluate potential health risks from exposure to amphibole minerals present in the ABM Ridge ore deposit. The indicator paramater used to evaluate potential health risks is the **quantitative estimate of increased cancer risks due to project operation.**

ISSUE 7 - TRANSPORTATION IMPACTS

The impacts of transportation of concentrates to the exfoliation plant in Butte would cause traffic safety concerns, wildlife disturbance, increased noise and dust, possible reduction in real estate values, and additional road maintenance. The indicator parameter is the **number of vehicles of various types and weights on the haul road each day.**

2.2 ALTERNATIVE 1 - STANSBURY'S PROPOSAL

A summary of the application to amend the Operating Permit No. 00094 (Stansbury Holdings Corporation, 1990a) is included here. However, the entire application (or Plan of Operations) including all project details and maps is considered the proposal, and is available for public review at the following locations:

- Montana Department of State Lands, Helena office
- U.S. Department of Agriculture, Forest Service, Bitterroot National Forest (BNF) Supervisor's Office, Hamilton, Montana
- U.S. Department of Agriculture, Forest Service, Darby Ranger District, Darby, Montana

The Stansbury Holdings Corporation, hereafter referred to as Stansbury (operating as Western Vermiculite Company) was issued Operating Permit No. 00094 by the Montana Department of State Lands (DSL) and an Approved Plan of Operations by the Forest Service in 1979. The permits allowed the company to mine the vermiculite on 20 acres of Forest Service land in the SE1/4 of Section 24, T6N, R19W and the W1/2 of Section 19, T6N, R18W, and mill on 10 acres of private land in the SE1/4 of Section 21, T6N, R19W.

The proposed amendment addresses 139.2 acres (including the permitted 20 acres on Forest Service lands) in the S1/2 of Section 24, T6N, R19W. The proposed permit area would accommodate all anticipated mining disturbance of the ABM Ridge deposit. Table 2.2-1 shows additional details regarding planned acreage disturbance.

Mining claims were first located on the vermiculite deposit in 1930 by Swift Chamberlain and Bert Garnett. Three years of exploration, consisting of shallow pits and short adits, were followed by a lease to a firm from Minneapolis, Minnesota, which constructed a road to the property between 1934 and 1936.

The claims were leased in 1947 to Robert Chamberlain and Cliff Jacobson, who were incorporated under the company name of Gird Creek Vermiculite Products Company, Inc. The company improved the road to the mining property, constructed an exfoliation plant in Hamilton, and produced finished expanded vermiculite, which it sold throughout the state. Homes in Ravalli and Missoula counties were insulated with the vermiculite, as was a new hall expansion to the Eagles Aerie in Hamilton.

After the mine had been inactive from 1950 to 1955, Verlite Mines, Inc. was formed to operate the mine. The access road was again improved but the mine was not put back into production.

National Vermiculite Company of Missoula obtained a lease to the property from Robert Chamberlain in 1976. A partnership with Argee Corporation of Iowa was formed to develop the mine as the Western Vermiculite Company. Between 1976 and 1979 the partnership conducted a drilling program, improved

TABLE 2.2-1

PLANNED DISTURBANCE BY PROJECT FEATURES

Feature	Acres	
	Disturbance Area	Permitted Area
ABM Ridge Facility Site	22.9	52.0
Host Rock Waste Stockpile	46.5	66.4
Haul Road	--	20.8
Widening	4.6	--
New Roads	2.7	--
Totals	76.7	139.2

Source: Stansbury Holdings Corporation, 1990a.

the access road, and, under a small miner's permit, built a pilot concentrator at the mine site on ABM Ridge. Two rail cars of vermiculite concentrate were shipped to Chicago for product evaluation. In 1979 the Western Vermiculite Company obtained permits for mining of the ABM Ridge deposit, and a pilot-scale concentrator and waste stockpile were constructed on private land adjacent to the Bitterroot National Forest.

In 1985, Stansbury Mining Corporation acquired Western Vermiculite Company and its holdings. In 1986, Stansbury submitted a plan for exploration on ABM and Horse Ridges which was approved by BNF and DSL.

In the spring of 1987, Stansbury Mining Corporation, doing business as Western Vermiculite Company, submitted an application to amend the permits issued in 1979. In 1990, Stansbury Mining Corporation stockholders approved a name change to Stansbury Holdings Corporation.

MINING PLAN AND MINING METHODS

Mine Plan

The ABM Ridge vermiculite ore deposit appears to be part of a deposit which is about three miles long by one mile wide, trending northeast-southwest. Although vermiculite is evident on the surface throughout this area, only two areas have been explored up to the present: the ABM Ridge deposit and to a limited extent, the Horse Ridge deposit located to the east (Figures 2.2-1 and 2.2-2). Mining of the Horse Ridge ore deposit is not a part of this application and would be considered in a separate Plan of Operations submitted by Stansbury.

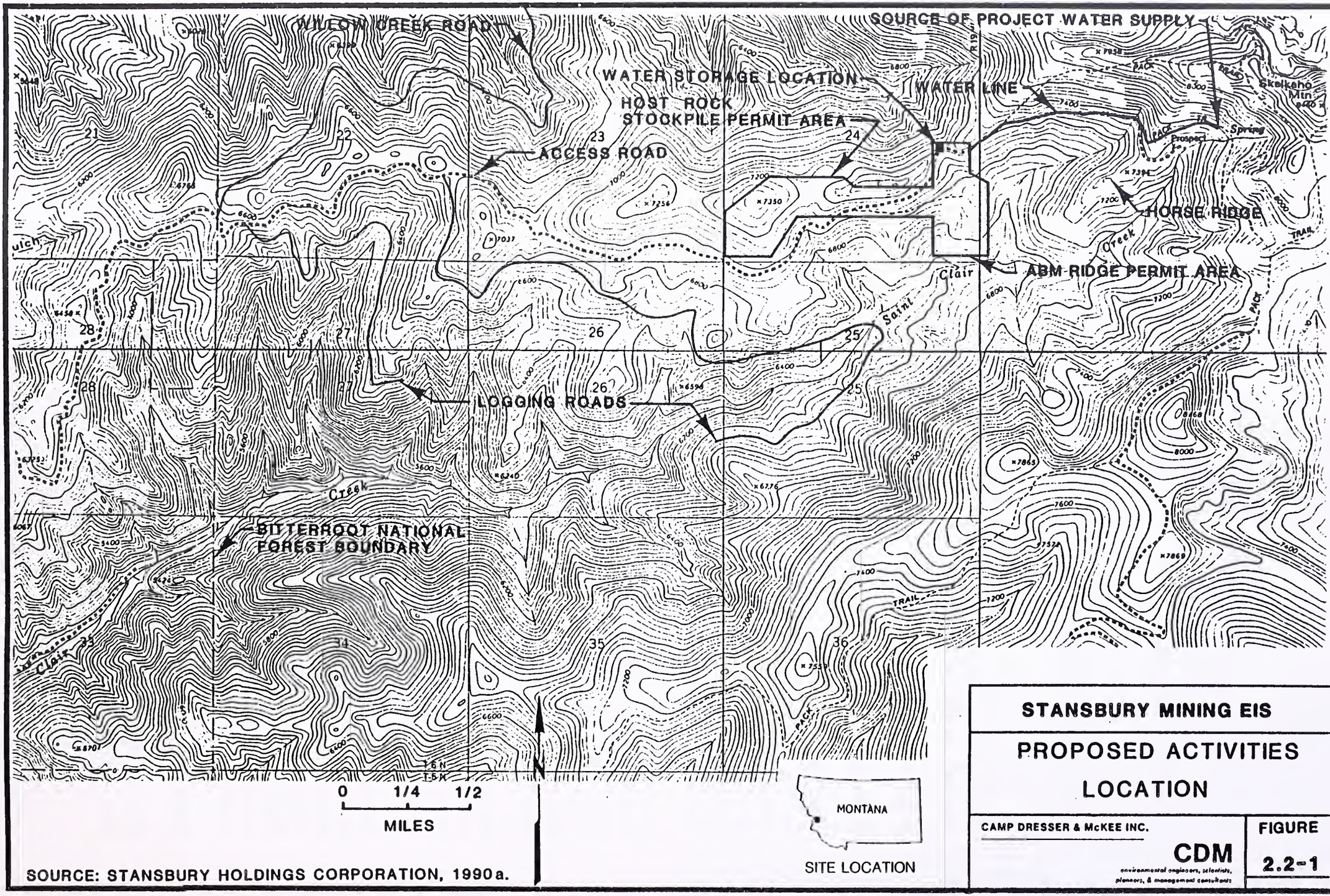
It is estimated that the mining of the ABM Ridge deposit would be completed in five to eight years. Reclamation would be completed in not more than two years after cessation of operations. The ABM Ridge deposit is minable from the surface to a depth of 250 feet in the center and 10 feet on the edges of the ore body. Since the deposit is located on the nose of the ridge, the mined out topography would not result in an enclosed pit except for the final 50 feet of mining. This depression would be filled during reclamation (Figures 2.2-3 and 2.2-4).

Beginning at 6,980 feet elevation, the mine would be developed by open pit methods to 6,680 feet elevation. The deposit would be mined in 20 to 25 foot lifts or benches, progressing from the south end of the ridge northward toward the concentrator. It is anticipated two or more benches would be mined at one time in order to provide an even feed grade to the concentrator.

Because the ore body is highly weathered and loosely aggregated or crumbly, dozers would be used to rip the ore into the working benches and then push the loosened ore into stockpiles. A front end loader would then scoop the ore to a conveyor feed system which would carry it to the concentrator. This conveyor system would be periodically extended to limit the lift and length of its haul. Small haul trucks might be used in the lower elevations of the pit. Because of the very loose, unconsolidated nature of the deposit, no blasting is expected to be necessary. However, should blasting be required at depth, a plan would be developed and submitted to the agencies for approval.

Employment

Employment for the Western Vermiculite Project is estimated at a maximum of 60 employees for the mine, concentrator and trucking. Seven people would be employed by Stansbury on a full-time, year



SOURCE: STANSBURY HOLDINGS CORPORATION, 1990a.

STANSBURY MINING EIS

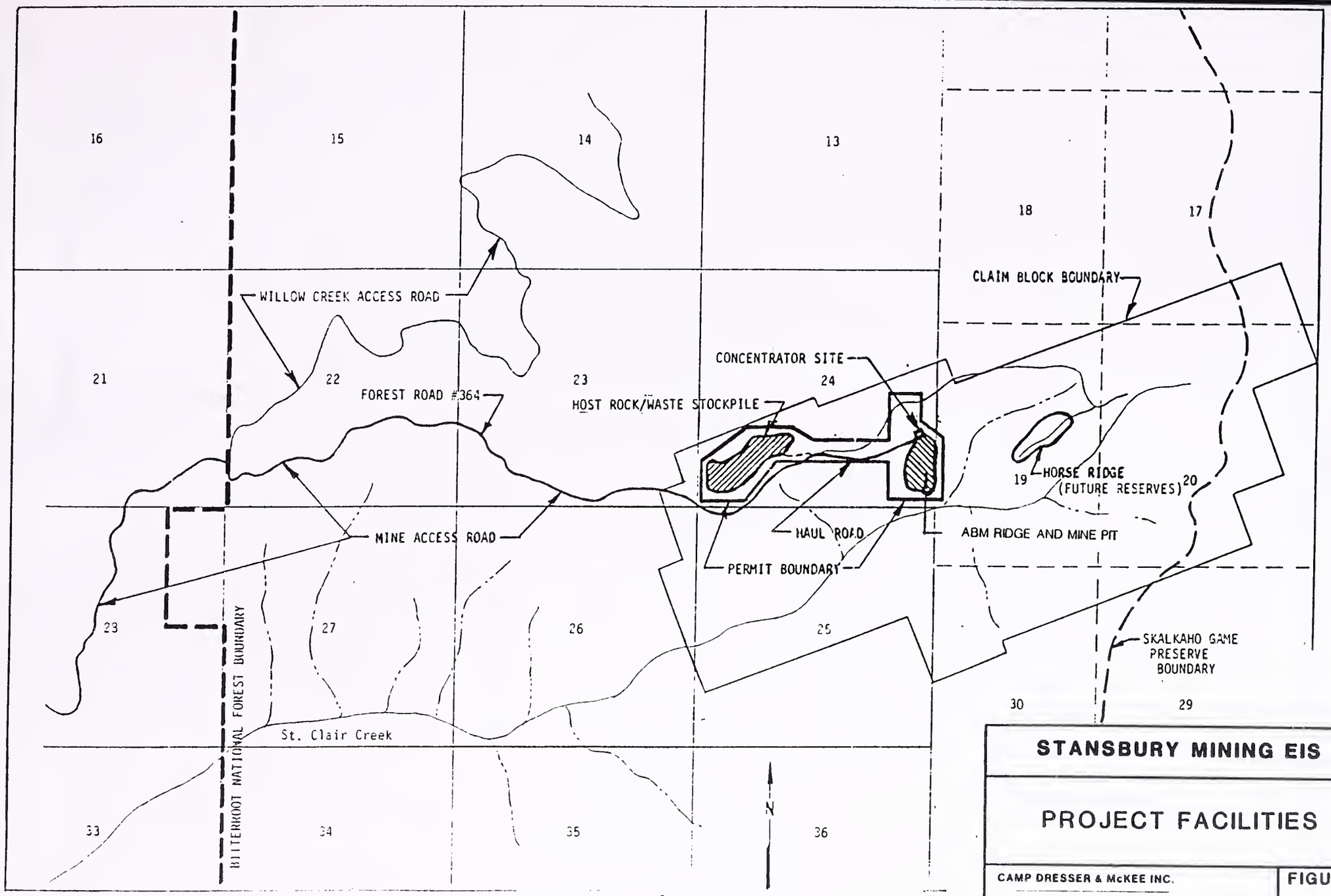
PROPOSED ACTIVITIES LOCATION

CAMP DRESSER & McKEE INC.

CDM

environmental engineers, scientists, planners, & management consultants

FIGURE 2.2-1



Source. Stansbury Holdings 1990a.

STANSBURY MINING EIS

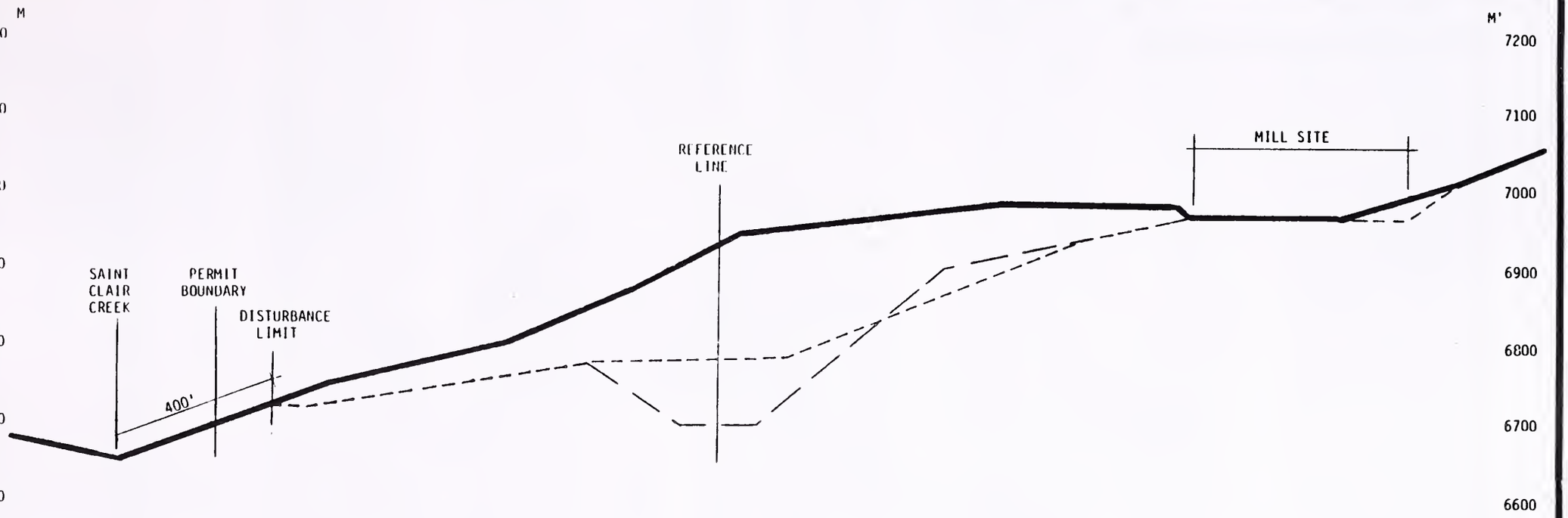
PROJECT FACILITIES

CAMP DRESSER & McKEE INC.

CDM
environmental engineers, scientists, planners, & management consultants

FIGURE
2.2-2

M'
7100
7000
6900
6900
6800
6800
6700
6700
M
FILL
SETTLING POND
FACILITIES AREA AND ROAD
DISTURBANCE LIMIT
PERMIT BOUNDARY
0
100
200
SCALE
FEET
SOURCE: ADAPTED FROM STANSBURY HOLDINGS, 1990 a
STANSBURY MINING EIS
DISTURBANCE LIMITS
AND PERMIT BOUNDARY
CAMP DRESSER & McKEE INC.
CDM
FIGURE
2.2-3



EXISTING SURFACE

FINAL MINE SURFACE

RECLAIMED SURFACE

SOURCE: STANSBURY HOLDINGS, 1990a.

STANSBURY MINING EIS

MINE TOPOGRAPHY AND RECLAIMED SURFACE

CAMP DRESSER & McKEE INC.

CDM

environmental engineers, scientists, planners, & management consultants

FIGURE 2.2-4

round basis in professional positions. The remaining jobs for this project would be six month positions. Stansbury would employ 25 skilled and unskilled workers for the concentrator during its six month operating schedule. Mining and trucking would be contracted. It is anticipated that mining and waste rock haulage employment would be 20 employees. Contract trucking of concentrates to the Butte/Silver Bow exfoliation site would employ eight additional workers. Stansbury would have a policy of hiring and training from the local labor pool and would encourage its contractors to do so as well.

CONCENTRATING METHOD

A concentrating facility would be constructed on the north end of ABM Ridge. This site was the location of the pilot concentrating facility constructed by the previous developers. The concentrator would produce vermiculite concentrates in six size gradations.

The ore processing is based on classification and air winnowing of the vermiculite to separate it from the host rock. The pit fed ore would be dried using an oil-fired dryer and run through a series of crushers, magnetic separators, screens, and air classifiers (winnowing machines). The separated host rock and magnetic material (magnetite ore) would be placed in bins for loading and haulage to the HRWS (Host Rock Waste Stockpile). The six product sizes of vermiculite would also be placed in bins for loading into trucks for shipment.

All concentrating equipment (screens, crushers, and conveyors) would be contained or hooded and subject to a dust collection system (bag house system) of the best available control technology (BACT). No chemicals would be used in the recovery process except as suppression agents in the dust collection system. The dust collecting system would be a continuous self-cleaning system. The collected dust would be agglomerated and then conveyed to the host rock waste bins for disposal.

The vermiculite concentrates would be stored in bins and subsequently hauled by truck to the exfoliation plant in Butte.

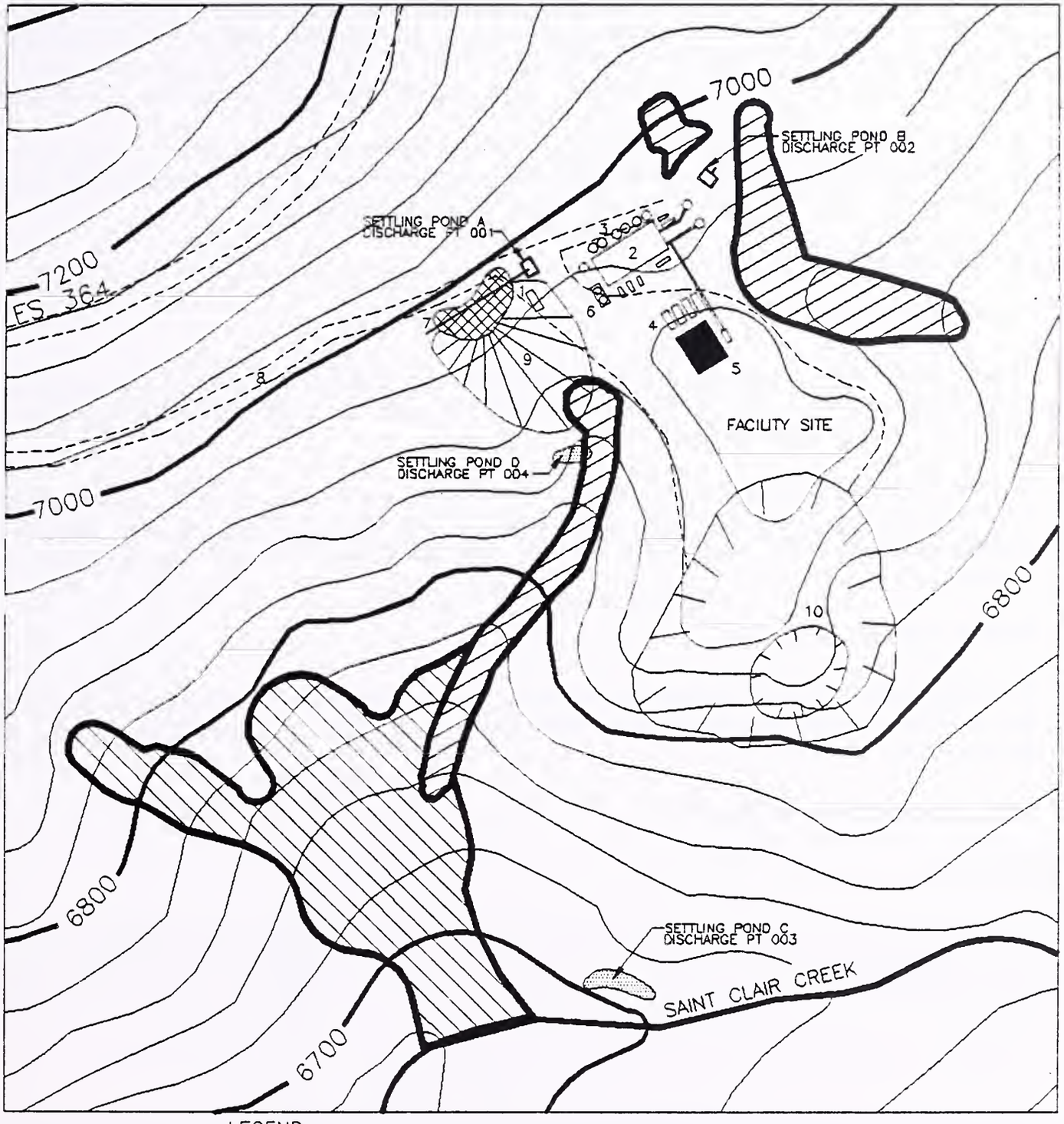
HOST ROCK WASTE STOCKPILE (HRWS)

The waste rock and magnetite from the concentrator, major actinolite dike materials, and other in-pit waste rock, would be hauled by a fleet of three 35-ton trucks via the HRWS haul road to the HRWS. The HRWS is located about 0.75 miles to the west and uphill from the ABM Ridge mine and concentrator site (Figure 2.2-1). It is near the crest of the divide between the St. Clair Creek and Butterfly Creek drainages.

The HRWS would be built in incremental stages, beginning from the lower end and proceeding uphill. In the first stage, topsoil would be stripped and piled for reclamation of the final stage. Otherwise, soils from the new level would be used to reclaim the previous portion. After stripping topsoil, the bedrock would be terraced to provide a base for fill materials. Waste would be dumped and periodically pushed and compacted by dozer to the finished grade of 2.5h:1v, with benches 10 feet wide for every 40 feet of lift. The top of the HRWS would be flat.

INFRASTRUCTURE

An overview of the mine facilities and layout is presented in Figure 2.2-5. All facilities and structures would be painted in neutral, earth-tone colors designed to blend into the surrounding area.



LEGEND

WETLANDS CLOSELY ASSOCIATED WITH ABM RIDGE & POSSIBLE HYDROLOGICALLY TIED TO ABM

WETLANDS OF SLOPES ADJACENT TO ABM RIDGE & NOT LIKELY HYDROLOGICALLY TIED TO ABM

1 – OFFICE AND PARKING
2 – CONCENTRATOR
3 – LOADOUT BINS
4 – WAREHOUSE, TOOLROOM AND OFFICE TRAILERS
5 – VEHICLE MAINTENANCE AREA
6 – FUEL OIL STORAGE
7 – TOPSOIL STOCKPILE
8 – ACCESS/CONCENTRATE HAUL ROAD
9 – FILL
10 – MINE PIT

SCALE: 1" =300'

SOURCE: STANSBURY HOLDINGS, 1990 a & b.

STANSBURY MINING EIS

PROPOSED FACILITIES PLAN AND WETLANDS AREAS OF INTEREST

CAMP DRESSER & McKEE INC.

CDM

FIGURE 2.2–5

Equipment

A contractor would be used for the mining operation. Projected equipment needs for conventional mining at this scale include one D-8 dozer, one 988B loader, three 35-ton dump trucks, one water truck, one road grader and a mechanic's service truck. A small shop facility would be located on ABM Ridge.

A contractor would also be utilized for hauling concentrates from the mine to the exfoliating plant. A fleet of fifteen 18-ton trucks will be used. Each truck would consist of a tractor and two covered, conical hopper trailers. Tightly fitted canvas covers would be used on the trailers.

Water Consumption and Source

Water Requirements

Water requirements would be less than 30,000 gallons per day, used primarily for dust control on haul roads and for various uses in the mine and waste stockpile areas. A 10,000-gallon tank reserve for fire suppression would also be provided.

Stansbury proposes to develop the spring above the facilities area (Figure 2.2-6) and gravity feed by a 2-inch polyethylene pipe to two 10,000-gallon steel tanks located in the saddle above the mine. The company has applied for water rights with the Montana Department of Natural Resources and Conservation.

Potable Water Requirements

The complement of 40 to 60 workers per day would consume approximately one gallon per person per day, or 60 gallons total. It is planned to use bottled water, with potable water stations set up throughout the operations.

Power Consumption and Source

Electricity

Power requirements at the mine would be 1,000kW or less. Since the nearest major substation is about 6.5 air miles from ABM Ridge, and construction of a powerline would be both expensive and environmentally disruptive, it is proposed that electricity be provided by on-site diesel-powered generators.

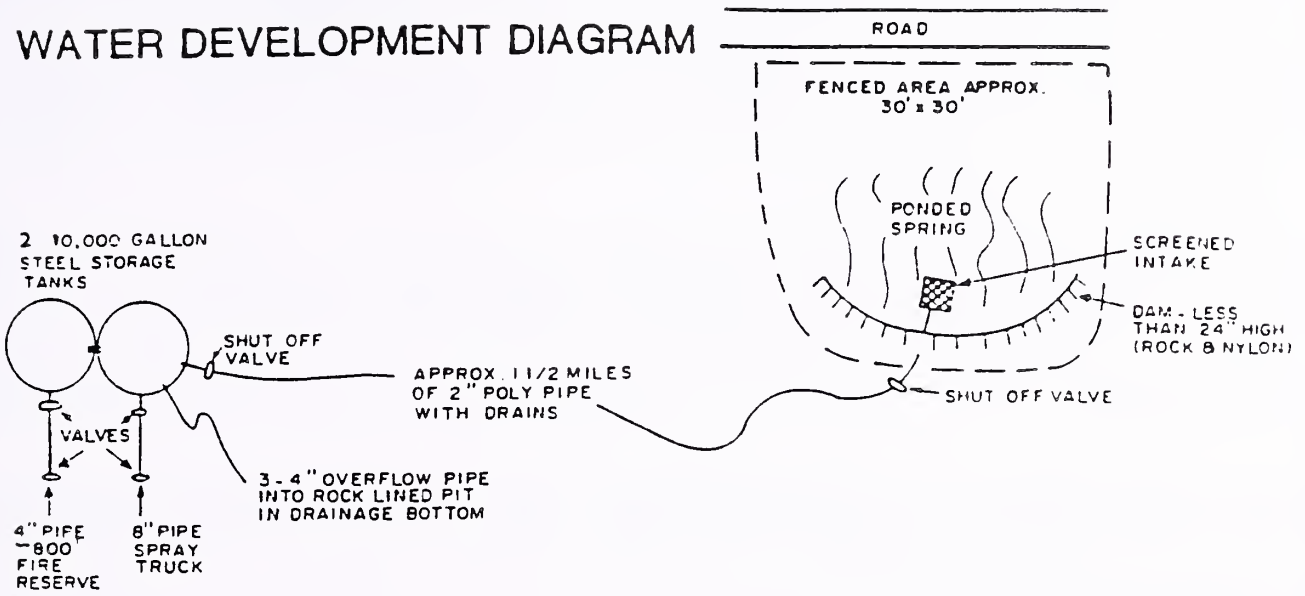
Fuel Oil

Fuel oil would be used to power the generator, fire the dryer, heat buildings, and fuel mobile equipment. Fuel oil would be delivered by tanker truck to the mine site and unloaded into a 30,000 gallon aboveground storage tank facility which has been designed to control and contain a spill one and one-half times storage capacity.

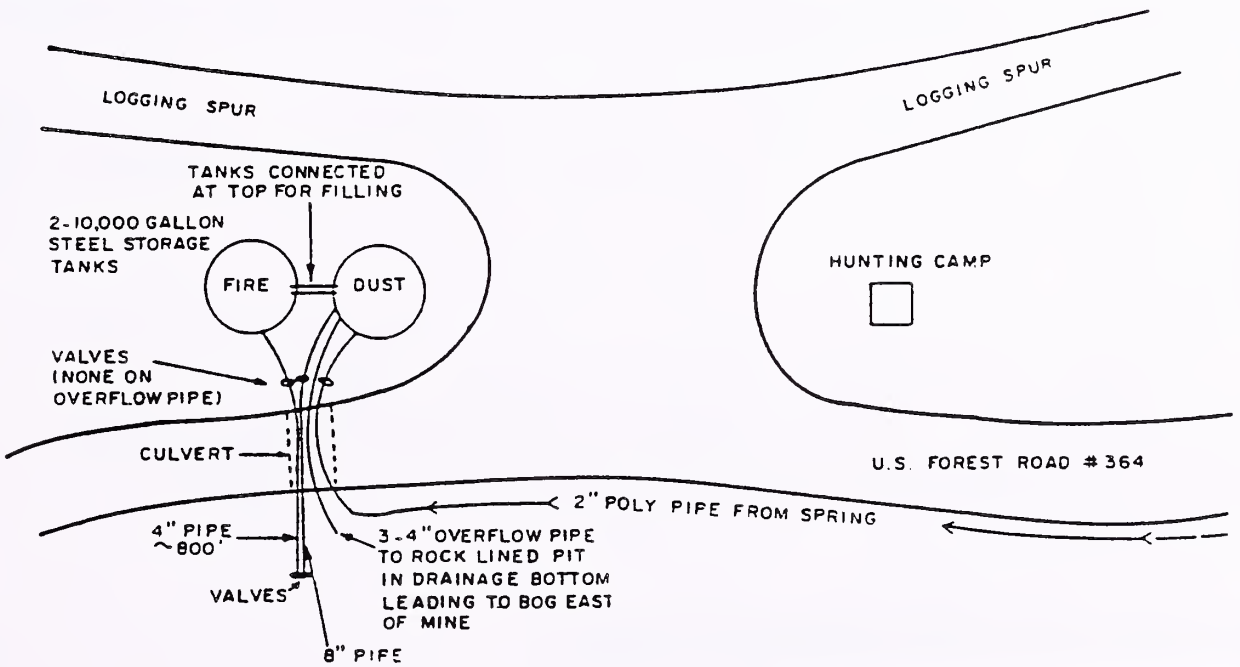
Vehicle Maintenance

The vehicle maintenance area would be utilized by the mining contractor. The contract between Stansbury and the mining contractor would specify procedures for salvaging of all waste oils, solvents,

WATER DEVELOPMENT DIAGRAM


ROAD
FENCED AREA APPROX. 30' x 30'
PONDED SPRING
SCREENED INTAKE
DAM - LESS THAN 24" HIGH (ROCK & NYLON)
SHUT OFF VALVE
APPROX. 1 1/2 MILES OF 2" POLY PIPE WITH DRAINS
2 10,000 GALLON STEEL STORAGE TANKS
SHUT OFF VALVE
VALVES
3-4" OVERFLOW PIPE INTO ROCK LINED PIT IN DRAINAGE BOTTOM
4" PIPE ~800' FIRE RESERVE
8" PIPE SPRAY TRUCK

STORAGE TANK AREA



SOURCE: STANSBURY HOLDINGS, 1990a.

STANSBURY MINING EIS

WATER DEVELOPMENT PLAN AND DETAIL

CAMP DRESSER & McKEE INC.

CDM

FIGURE 2.2-6

or other controlled substances in containers for either recycling or disposal. Procedures would be instituted for cleanup of small spills or contaminated soils. Any spills of greater magnitude than one 55-gallon drum would be treated as a major spill and handled as described in the Spill Contingency Plan section.

Sewage and Solid Waste Disposal

Portable chemical toilets would be used at the mine and concentrator site. Sewage and domestic solid waste would be hauled by a contractor to a sewage treatment plant, an approved County landfill, or buried in a permitted on-site waste disposal area.

Communications

Due to the prohibitive cost of providing phone service to the mine site, radio-telephone communications would be established between the mine and the valley. Radios would be necessary for haul trucks to coordinate traffic safety and shipments.

Spill Contingency Plan

The Spill Contingency Plan in the Operating Permit application describes the procedures and responsibilities of Stansbury, its contractors, employees, and suppliers in the event of a spill. Both dry materials, such as concentrate or waste rock, and liquids, such as fuel oil, are addressed.

All employees and other persons connected with this project would be informed of the proper procedures for spill prevention, materials handling, and cleanup.

Any spill which endangered human health or safety, compromised access, or caused potential degradation to either surface or ground water, would be reported to the Montana Water Quality Bureau, DSL, and Forest Service.

Fire Protection

Fire protection would be keyed toward prevention, especially through employee education, and would be in accordance with MSHA and U.S. Forest Service policies. In addition, a 10,000-gallon water tank with gravity feed to the concentrator area would constantly be available for fire suppression. The water truck would also provide mobile capabilities. Fire extinguishers, spark arresters, and tools of the appropriate type would be available at strategic locations.

TRANSPORTATION PLAN

Haul Road to Host Rock Waste Stockpile (HRWS)

The haul road from the mine and concentrator to the Host Rock Waste Stockpile (HRWS) would consist of 0.25 miles of new construction and 0.5 miles of rebuilt existing access road from ABM Ridge to Forest Service Road 364, for a total of 0.75 miles. The following road standards are set by MSHA: both sections of the road would be built with 40 feet of usable roadway with a constant 6.5 percent grade, except for a 150-foot section of 2 percent grade at the intersection with Forest Service Road 364. A 1.5 percent outslope on the roadway and cross drainage dips every 300 feet, leading to breaks in the 2.5 foot

berm, would release runoff. Construction of the road would begin as soon as permitting allowed, which would be in conjunction with the BNF providing engineering guidance on road design.

Revegetation to stabilize road disturbances would be performed during the first growing season after completion of construction. This road would be recontoured and reclaimed at end of mine life (see Reclamation section).

Access Road to Mine

Access to the project site would begin off the East Side Highway (State 269) on Hamilton Heights Road at the east section line of Section 13, T6N, R20W. The first seven miles south from the Hamilton Heights Road traverses private road in Charleys Gulch. The route then joins the public Forest Service Road 364 (FS 364) for approximately four miles.

No major reconstruction of the access route is planned by Stansbury. Upgrading of the access road surface may occur, and additional turnouts may be added, if traffic conflicts occur. Plans for improvements would be submitted to the agencies for approval prior to implementation, and revegetation would be performed in the first growing season after completion of improvements (see Reclamation section).

Since the access road would remain for Forest Service and private use after completion of mining operations, and vegetation would be established on any improvements, no recontouring would be necessary at the end of operations.

During operations, the access road would be routinely maintained by road graders patrolling the length of the road. Culverts, water bars, and similar erosion control features would also be regularly maintained.

Most road improvements required to safely and efficiently accommodate traffic, as well as minimize environmental impacts, would be constructed on the private section of road. Improvements may include installation of culverts, application of road surfacing materials, widening, grading, and new runoff controls. Final engineering plans would be coordinated with the DSL, BNF, Ravalli County, and private land owners prior to implementation.

Some screened and graded waste rock produced at the concentrator would be used for road gravel. This angular, non-toxic waste rock consists primarily of competent pyroxene, with minimal amounts of vermiculite or other remaining platy minerals. Tests of the waste rock shows that it meets requirements of the Montana Public Works standards for road surfacing. Little or no amphibole minerals are expected to be present in the road gravel (see Public Health Risk, Section 4.4). It is not anticipated that EPA or MSHA standards would be exceeded, or approached, for airborne concentrations of fibers that might be released as a consequence of the degradation of the gravel due to traffic or other causes. Stansbury plans to implement a monitoring program approved by the Air Quality Bureau (AQB) to insure the operation is in compliance with all standards. Coordination would be made with the appropriate agencies and private land owners before any gravel operations are undertaken.

Day shift traffic on this route due to mining operations is expected by Stansbury to include (with company encouraged carpooling) 10 to 20 employee, service, and delivery vehicles. About one-third as many vehicles are expected during other shifts. In addition, 15 trucks (18-ton capacity) would be hauling concentrates to Butte daily. Parking facilities would be located at ABM Ridge (Figure 2.2-5).

Mine to Exfoliator Near Butte

The transportation route would follow the access road from the mine to Hamilton Heights Road, at which point it would turn left onto Hamilton Heights Road for 4.5 miles. The route then turns right and travels north on the East Side Highway for 2.5 miles. At the intersection with Corvallis Road (State Road 373), the route turns left for two miles, until its junction with U.S. 93. After turning right onto U.S. 93, the transportation route follows U.S. 93 for about 45 miles to the southwest side of Missoula. At the Reserve Street intersection, the route again turns left, and follows Reserve Street until reaching Interstate 90. Once on I-90, the route trends eastward 115 miles to the Silver Bow Siding Access Road, and proceeds about half mile west to the exfoliation plant site. The total distance from mine to exfoliation site is 188 miles. No backhaul is anticipated.

RECLAMATION

Stansbury proposes to reclaim all disturbed areas. Revegetation of grasses, forbs, shrubs, and trees would support the reclaimed use of previous habitats. Revegetation of disturbed areas would be initiated in the first growing season after soil redistribution. The designed revegetation plan would control erosion and sedimentation, establish vegetative cover with characteristics similar to pre-mine conditions, and restore watershed, wildlife, and aesthetic values to meet post-mining land use objectives as specified in the agency permits.

Soil Salvage

Soils in all areas of disturbance would be salvaged to the greatest depth possible. Efforts would be made to minimize compaction during soil handling operations.

Before soil salvage, BNF personnel would designate merchantable timber to be felled and decked for sale. Remaining slash and vegetation would be stacked by brush cats and burned. Residue and all remaining plant material would then be salvaged with the soils.

Before soils are redistributed, surfaces of disturbed areas would be ripped to relieve compaction, eliminate slippage at layer contacts, and promote root penetration. Soils would be layered in a uniform thickness of about two feet, and would be applied in lifts as thick as possible to decrease compaction.

During mine operations, certain disturbed areas would be stabilized with interim vegetation to reduce erosion and sedimentation. These areas include haul road cut and fill slopes, settlement basin dams and diversion ditches, soil stockpiles, and the concentrator area. Because this is interim revegetation, these areas would not have soil redistributed on them, but would be broadcast seeded, mulched, and fertilized in the first growing season after construction.

At the completion of mining, all equipment, the concentrator and its building would be removed from the ABM Ridge site. The mined area would have the walls reduced to 2h:1v or flatter, and the pit filled to prevent an accumulation of water (Figure 2.2-4). The concentrator site would be graded to blend into the contour of the area, allow drainage, and prevent erosion. Topsoil would be redistributed, and the area would be totally reclaimed.

The haul road, diversion ditches, and containment ponds would be recontoured, and drainage patterns would be re-established.

Revegetation

Different seed mixes and rates of application have been proposed for grasses, forbs, and shrubs. Specific mixtures and rates are listed in the Plan of Operations. The seedbed would be prepared by discing or harrowing along the contour to break up large clods. Drill seeding would be used on slopes up to 33 percent and along the contour on sloped ground.

On slopes exceeding 33 percent, sites too narrow for equipment, or sites with slash or coarse fragments, the soil would be left in a roughened condition. The irregular seedbed would provide microsites for seed germination and would reduce soil movement.

Broadcast seeding with cyclone-type bucket spreaders, mechanical seed blowers, or hydroseeders would be used. If possible, areas would be chained, harrowed, or dozer tracked perpendicular to the slope to cover the seed and help increase germination.

Where hydroseeding is employed, seed, fertilizer, and mulch would be sprayed in one application, and a second application of mulch and tackifier would be applied.

Trees would not be planted on the haul or access roads, but would be planted on other areas. A mix of 65 percent Douglas-fir and 35 percent lodgepole pine would be planted. Trees would be ten feet apart in contour rows of two to four feet wide. These rows would be alternated with 8 foot-wide continuous strips seeded with an herbaceous revegetation mixture.

Either containerized or conventional planting techniques employing hand or power tools would be used. No tree stock would be handled when air temperature is below freezing, nor would any planting be done while frost is present in the soil.

As soon as final grades are established on the original level of the HRWS, topsoil would be distributed on the finished face to a depth of about two feet and reclamation would be started. This sequencing would result in less exposure of disturbed ground to erosion from wind and water, and allow the earliest reclamation of the disturbance.

WATER MANAGEMENT AND SEDIMENT CONTROL

The drainage and sediment control plan is designed to protect area water quality from sediment impacts due to the mining operation. The plan incorporates diversions, collection ditches, settling ponds, and revegetation to accomplish this goal. The intent of the plan is to retain on-site runoff within disturbed areas, and to channel off-site runoff away from disturbed areas into natural off-site drainage paths.

Mine

The mine drainage plan includes a diversion ditch upgradient of the disturbed area to direct runoff east and west away from operations into undisturbed drainageways. The haul road would collect some water and channel it toward the mine area. This runoff water would be diverted onto undisturbed areas by dips across the road as previously described.

Drainage within the mine and concentrator area would be retained by berms around the edge of disturbance. Runoff water would be collected in settling basins (see Figure 2.2-5). Settled water would

be decanted to adjacent drainageways as the ponds fill. These waters would also be available for road, stockpile and facility watering for dust control, and for fire protection as needed.

Sediment Pond C is tentatively located approximately 300 feet from St. Clair Creek. While Stansbury does not anticipate a problem with this location, site review during final planning for pond construction would be accomplished in conjunction with DSL and USFS and the exact location amended to the best location to protect St. Clair Creek and meet operational plans.

Ground water has been detected in the proposed mine pit area. Measures to control ground water discharge and water quality would be discussed with appropriate State and Federal agencies. Various methods have been proposed by Stansbury to address the issue. The means selected would be site- and situation-specific, and would meet Montana Pollution Discharge Elimination System (MPDES), DSL, and USFS criteria.

Some surface water would accumulate in the pit from snow melt and rain. This water is expected to be minimal and would generally be collected in a low area of the pit where equipment is not working, and would be allowed to seep and evaporate away. If the amount of water is great enough to be a problem for operations, it would be allowed to settle and be used for dust control or discharged to the perimeter settling pond for further treatment prior to discharge off the permit area. This discharge from the pit to the perimeter settling ponds would take place during a time period when the perimeter pond is low or empty, to take advantage of maximum retention and settling to provide the best treatment prior to discharge.

Host Rock Waste Stockpile (HRWS)

Some of the topsoil stripped from the waste stockpile area would be used to construct a retention berm along the toe of the fill. Settling ponds would be constructed in appropriate locations to collect and settle runoff water from the waste stockpile. As the waste stockpile is constructed, finished faces would be revegetated to reduce erosion. Operational deposition of waste rock would maintain the edge of fill slightly higher than the working surface in order to minimize runoff over the exposed face. Water from the working surface would be collected in a ditch near the interface of fill and natural ground, drained to the perimeter collection ditch and into the sediment pond.

As another erosion control measure, the perimeter of the mine, concentrator, and HRWS disturbance areas would be encircled by a system of diversion and collection ditches and settling ponds to prevent erosion and discharge of sediment in runoff from the site.

Haul Road

The haul road would be sloped to the outside and all cuts and fills would be revegetated as soon as practical after construction. Runoff from the road surface would be discharged to natural drainageways via dips across the road and cuts through the safety berm. Revegetation would be used to control fill slope erosion; short log sections or possibly road riprap would be used at point of discharge into natural drainageways.

Sedimentation control would be accomplished through seeding of road cuts and fills, construction of cross dips at 300-foot intervals to reduce flow velocity and volume, and sloping the road toward the fill side to minimize road drainage.

Design Criteria and Calculations

Design criteria and calculations for ditches, settling ponds, runoff and sediment control structures, and other project engineering features are included in the Operating Permit application (Stansbury Holdings Corporation, 1990a).

OPERATIONAL MONITORING

Stansbury has committed to monitoring of several activities during operations. Among these are the following notable items:

1. Air quality monitoring at the mine site and on access haul road, as required by the State Air Quality Permit (to be obtained); also, MSHA air monitoring for worker safety.

2. Monitoring of reclamation success as required under the Plan of Operations (USFS) and Operating Permit (DSL).

3. Monitoring of 2 surface water sites - one above and one below the mine - on St. Clair Creek for flow and turbidity (to determine effectiveness of sediment control) - 4 samplings.

4. Monitoring of road damage and road maintenance or improvements needed on the concentrate haul road (private and FS sections).

5. Monitoring of noise from haul trucks.

2.3 ALTERNATIVE 2 - STANSBURY'S PROPOSAL WITH MODIFICATIONS

Although the company has committed to many items in the Proposed Plan of Operations as described in Alternative 1, the agencies preparing this EIS have considered a number of additional mitigational measures under Alternative 2. All other aspects of Stansbury's proposal would remain as stated in Alternative 1. The proposed modifications are based on the potential adverse environmental impacts identified during the EIS process (Chapter 1.0). The modifications are intended to minimize potential adverse environmental impacts of mine development, and/or to monitor potential environmental impacts to ensure they remain within acceptable and predicted limits. The format below follows the discussion for Alternative 1, although several mitigation measures apply across various project features.

MINING PLAN AND MINING METHODS

Alternative 2 specifies the following mitigation measure to the proposal:

- In contrast to an outwardly draining pit except for the last 50 feet of mining (as specified in Alternative 1), the **pit would be inwardly draining throughout mining operations** to collect, monitor, and evaluate ground water.

CONCENTRATING METHOD

No changes to the concentrating method are proposed.

HOST ROCK WASTE STOCKPILE (HRWS)

Operation of the HRWS would be modified in the following manner under Alternative 2 to mitigate anticipated impacts:

- **The HRWS would be confined to clear-cut area only, to avoid a small stand of native Western needlegrass identified at the site, if possible.**

INFRASTRUCTURE

No changes to the infrastructure are proposed.

TRANSPORTATION PLAN

The transportation plan as proposed by Stansbury in Alternative 1 already incorporates many mitigation measures, and notes that others would be developed on an "as-needed" basis. In order to address other surface water and sediment control, and transportation issues noted in Section 2.1, the following mitigation measures would be specified for Alternative 2:

- **Construction of the HRWS haul road would be accomplished with 1-1.5:1 cut and fill slopes** in order to minimize disturbance on steeply sloping areas at the top of ABM Ridge. Figure 2.3-1 shows an approximate recommended road cross-section.

- **Surfacing of the HRWS haul road and the access road with waste rock** would be done to control dust, erosion, and sedimentation.

- **Specified improvements to FS 364 for concentrate haulage** would include widening to accommodate trucks, turnouts for passing, and improvements in sight distance and drainage prior to operations.

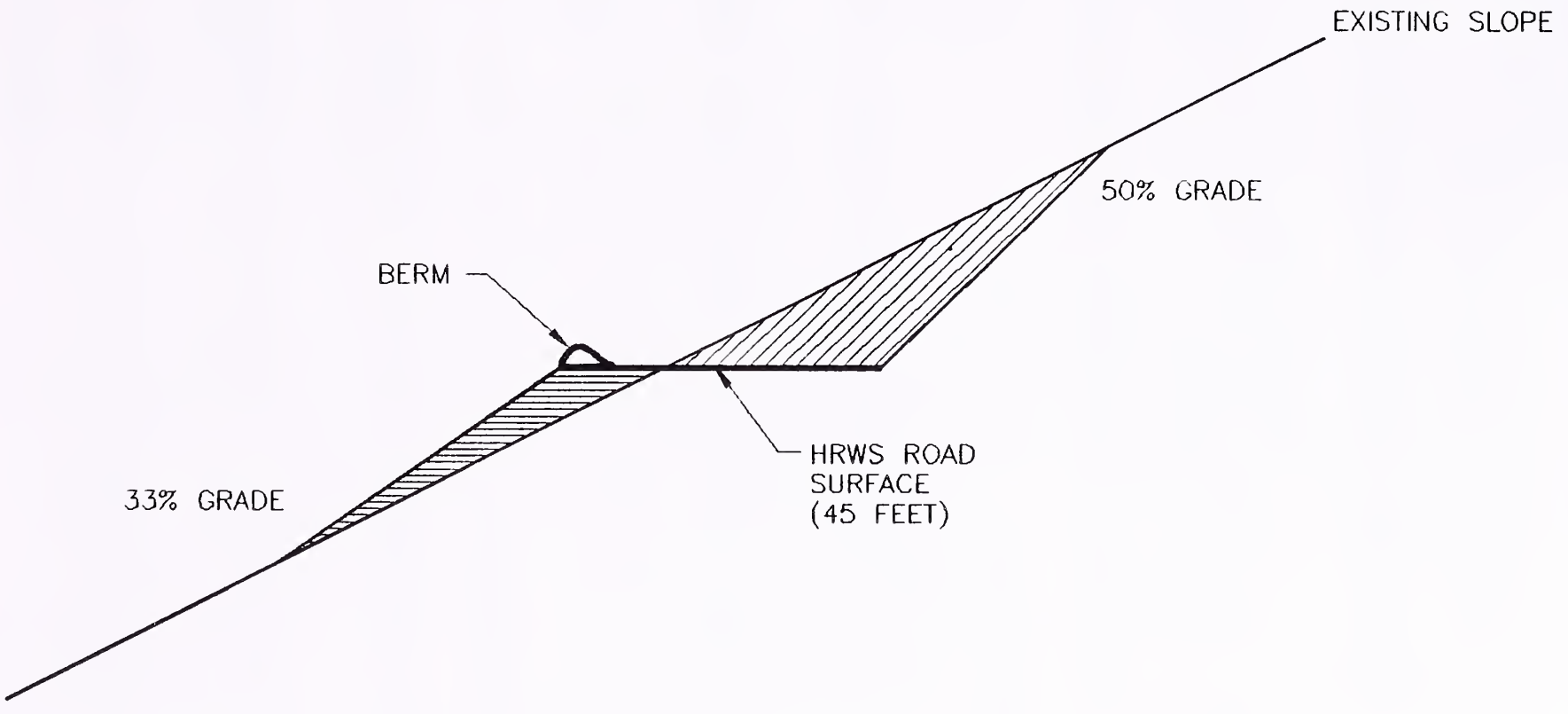
- **Bussing of workers** to the mine site from Hamilton or from a central parking lot in the Bitterroot Valley would be required, in order to minimize structural transportation impacts on the road, to improve safety through less traffic, minimize noise and dust, reduce wildlife disturbance, and discourage potential poaching.

- **Alteration of road design through wetland area** would occur near the mine site to minimize encroachment into wetlands.

- **Closure of FS 364 from the mine site east towards Skalkaho Mountain** (a distance of approximately 0.75 miles) in order to minimize wildlife disturbance and allow wildlife movement across this area.

RECLAMATION

In addition to the numerous reclamation standards and features proposed by Stansbury to effectively address surface features in Alternative 1, the proposed mitigation for Alternative 2 would further address the following:



KEY

CUT SLOPE

FILL SLOPE

0 15 30

SCALE IN FT

SOURCE: ADAPTED FROM THOMPSON, 1990.

STANSBURY MINING EIS

CROSS-SECTION, PROPOSED HRWS HAUL ROAD CONSTRUCTION SPECIFICATIONS

CAMP DRESSER & McKEE INC.

CDM

FIGURE 2.3-1

- **Mine pit walls would be reduced in slope to 2.5:1** to minimize erosion and sedimentation, and to enhance stability.

- **Baseline spring flows** would be characterized and monitored prior to mining; and primary springs would be monitored during mining to assess impacts.

- **If wetlands are lost due to mining operations, establishment of equal wetland acreage,** either in the reclaimed pit area or elsewhere, would be accomplished during reclamation.

WATER MANAGEMENT AND SEDIMENT CONTROL

Stansbury has proposed several measures to reduce surface water, ground water, and sedimentation impacts during project construction and operation. Under Alternative 2, the following mitigation measures are proposed to address this important issue.

- Develop a **method to dispose of excess mine pit drainage water** consistent with the hydrologic budget and water rights concerns at the site (see Mine Plan above).

- **Minimize wetland impacts**:

  1. Relocate soil storage site.
  2. Relocate sediment Pond D out of wetlands.
  3. Route interceptor ditches to lessen direct and indirect impacts to wetlands.
  4. Relocate sediment Pond B outside of wetland.
  5. Relocate mine buildings and other facilities out of wetland areas.

- Regarding water supply to the mine and given surface water rights consideration, **wells would be drilled on ABM Ridge to supply 50 gpm** (30,000 gals/day) for project uses. Wells producing less than 100 gpm are **not** subject to water rights permits.

- **Modification of surface water control system** to minimize potential sediment discharges to St. Clair Creek.

OPERATIONAL MONITORING

Stansbury has proposed to monitor a number of sites and parameters regarding project impacts to air, surface and ground water, soils/geology, and worker and human health. However, a number of other specific monitoring activities are proposed in this Alternative 2 to address issues of concern:

- **Surface water flow and quality (for fibers, sediments, and other parameters)** would be monitored at least monthly in St. Clair Creek for one year to establish baseline, using a continuous flow recorder and manual sampling. Sampling would continue until one year after reclamation.

- **Ground water inflow and quality** would be monitored monthly in the mine pit.

- **Spring flow and quality** would be monitored monthly (see Reclamation).

After baseline conditions have been established for the above parameters, the regulatory agencies would adopt appropriate monitoring programs.

2.4 ALTERNATIVE 3 - NO ACTION

Under this alternative, Stansbury would not develop the Western Vermiculite Project. The environmental, social, and economic consequences of project development described in Chapter 4.0 would not occur. If the No Action alternative is selected, the bond presently held by DSL for past disturbance at the site would be used for reclamation.

2.5 ALTERNATIVES CONSIDERED BUT DISMISSED

The scoping process identified a number of additional alternatives which were considered by the agencies. Alternatives described in this section have been dismissed from further consideration, and are summarized in Table 2.5-1. Reasons for dismissal are described in detail in the following sections.

GENERAL PROJECT ALTERNATIVES

1. Operate under the 1979 Operating Permit No. 00094. Under this alternative, the mine plan would follow the plan approved in 1979: mine the ABM Ridge deposit with a dozer, loader and haul truck operation; construct an improved road to the ten acre mill site on private lands four miles to the west in Charleys Gulch; construct the redesigned concentrator on the leased private lands there; deposit the host rock waste in a fill deposit below the concentrator at the head of Charleys Gulch and; haul the concentrates down the private access road for shipment.

   This alternative was rejected due to: increase in proposed surface disturbance, excessive distance between mine site and ore concentrator, unavailability of land for future host/waste rock stockpiles, and potential need to backhaul.

2. Location of the concentrator on the saddle directly above ABM Ridge between the St. Clair Creek and Butterfly Creek drainages (the proposed water tank holding site).

   This site was rejected due to: impact on the Forest road system; visual impact; requirement for additional road building for access to the site; additional disturbance area to accommodate the plant and; possibility of vermiculite reserves to the west of the site in the concentrator location.

3. Location of the concentrator in the SW1/4 of Section 23, on the saddle between the St. Clair Creek and Eastman Creek drainages.

   This alternative was not chosen due to: impact on Forest road system; visual impacts; distance from ore deposit and; area of land disturbance.

4. Location of exfoliation plant in Hamilton, Montana. This was the preferred alternative in the original plan. The exfoliation plant was to be located on Fairgrounds Road across from the Ravalli County maintenance shop on property to be annexed into the city. The concentrate would have been stored at an "interim stockpile site" at the end of the access route from the mine (in Charleys Gulch). From this location, the feed for the plant in Hamilton would have been shuttled in on an as-needed basis.

TABLE 2.5-1

SUMMARY OF ALTERNATIVES CONSIDERED BUT DISMISSED

Alternative Category & Detail	Reasons for Dismissal
• General Project	
- Concentrator and host/waste rock stockpile in Charleys Gulch 4 mi. west of mine site	- Haul road distance; limited land availability
- Concentrator on saddle above ABM Ridge	- Road, visual, future mineral resource impacts
- Concentrator on saddle between St. Clair and Eastman Creek drainages	- Road, visual, hauling distance, land disturbance impacts
- Exfoliation plant in Hamilton	- Public opposition, potential air quality impacts
- Rail haulage to exfoliation plant in Butte	- Cost-efficiency, air quality impacts at transfer point (truck/rail) at Victor
- Host/waste rock stockpile alternatives	- Five rejected due to technical and engineering infeasibility, proximity to St. Clair Creek, haul road distance, Forest road and visual impacts
• Mining Plan	
- Underground mining	- Technically and economically infeasible for this ore body with surface resources
• Concentrating Plan	
- Wet processes	- Water requirements and management, reagent spills, increased costs, ability to control dusts using dry process is adequate
• Transportation Plan - Concentrate Haulage to Exfoliation Plant	
- Turn south on East Side Highway to avoid Corvallis school zone; on to Missoula	- Mitigation measures to truck haulage through Corvallis are adequate; other route conflicts here
- Use State Highway 38 south over Skalkaho Pass to Anaconda	- Traffic conflicts on recreational and scenic route; difficult grade and condition for trucks
- Construct new road access upgrading existing FS road to connect St. Clair Creek drainage area directly to State Highway 38	- Contrary to FS road planning policy for this area; considerable upgrading needed; difficult for trucks to negotiate; wildlife impacts; safety
• Power Supply	
- Gas/electric supplied by Montana Power Co.; transmission lines from valley floor	- Costs; corridor environmental impacts

This alternative was rejected due to public desire that the exfoliation plant facility not be located in Hamilton. Concerns with asbestiform particles in airborne dust were raised. (See the Public Health Impacts discussion in Section 4.4 of this EIS).

5. Haul by rail to exfoliation plant (Butte or elsewhere in the United States). This alternative would have used trucks from the concentrator to a small stockpile and load-out facility to be built at the siding in Victor, Montana, as stated in the original permit of 1979. Shipments by rail of concentrate to the exfoliation plant at Butte or another location would have followed.

   This alternative was not selected because it does not appear to offer any substantive advantages over trucking (additional transfer facilities, multiple handlings, no cost advantages). However, the company may wish to re-evaluate this proposal due to factors which have changed since the plan was initially developed.

6. Six host rock waste alternative stockpile sites were considered and are identified in the permit application (see Supplement - Company's Assessment of Impacts, p. 7). Three were considered technically feasible. Site A, the proposed plan on ABM Ridge, was finally chosen. Sites B and C were rejected due to proximity to St. Clair Creek, Forest road conflicts, visual resources impacts, and haul distance.

MINING PLAN

1. Underground Mining - This is an ore deposit with values from the surface to depth and as such, underground mining would be economically infeasible and was not considered an alternative.

CONCENTRATING PLAN

1. Use of various wet processes to concentrate the vermiculite ore. These processes were researched during the planning stages of the project. This alternative would have been one means to control dust emissions from the concentrating process.

   This alternative was not selected. Use of these processes would have resulted in some or all of the following impacts: increased requirements and usage of water; increase in disturbed areas for recirculation of water; need for tailing impoundments; possible failure of impoundments; possible spills of reagents required in processing; increased diesel fuel requirements for drying; and additional chemicals. Utilizing a BACT (Best Available Control Technology), as required by air quality permits, a dust collection system on the selected system would be equally effective in suppression of discharge of particulates.

TRANSPORTATION PLAN

1. At the west end of Hamilton Heights Road, transport the concentrate shipments south via the East Side Highway to Fairgrounds Road to Highway 93. Turn north on 93 to Missoula and the Interstate highway to the Butte/Silver Bow exfoliation facility.

   This alternative was considered as the proposed haul route, or for alternative use during the period of operation while the Corvallis school system is in session. After study, it was decided

that it was preferable to continue with the proposed plan - north on the East Side Highway to Corvallis - and to mitigate as follows: schedule shipments to avoid school bus operations; strict observation of posted speed limits and; notify drivers of school zones and other hazard areas during safety training.

The alternative route was therefore rejected because it would: conflict with traffic to the Daly Mansion on the East Side Highway; conflict with fairground users in Hamilton; add to traffic entering Highway 93 from Fairgrounds Road and; require a left turn onto the East Side Highway which has limited distance vision of southbound traffic.

2. Utilize the above route to Highway 93 and proceed south to the Skalkaho Pass road (State Route 38) to Anaconda and Interstate 90.

   This alternative was not selected for proposal since the route: would require passage through the Hamilton area on Highway 93; would conflict with traffic on a scenic route; would create a hazard to visitors to Skalkaho Falls; would increase impacts on elk and deer summer range; and would be a difficult route (grade and condition of the roadway) for the ore trucks.

3. Construct a new access road from the mine to State Route 38 to connect existing timber access roads from the St. Clair Creek drainage with existing timber roads from the Gird Creek drainage. This would include upgrades to FS 714 (Gird Point) and FS 1369/1365 (Buckhorn Saddle vicinity) with connections to State Route 38 near the Black Bear campground.

   This alternative was eliminated because the USFS has altered road planning to prevent a continuous road system from Willow Creek to Skalkaho. The timber road system would also need considerable upgrading for ore trucks. Additional adverse impacts identified include safety concerns, conflicts with wildlife viewing on Skalkaho Pass, increased impacts on elk and deer summer range, steep slopes, and construction difficulties and costs.

POWER PLANT

1. Support of the concentrator by gas and/or electricity supplied by Montana Power Company from valley floor.

   Estimates prepared by Montana Power Company for supplying the project with gas and/or electricity showed this alternative to be cost-prohibitive; corridor construction impacts may also pose adverse environmental impacts.

2.6 COMPARISON OF ALTERNATIVES

The Western Vermiculite Project as proposed by Stansbury could have potential impacts regarding seven major issues. These issues were described in detail in Section 2.1.

Table 2.6-1 summarizes the major issues as they are affected by the implementation of each alternative. This table will allow the reader and decision-maker to more effectively assess impacts of the various alternatives against the key environmental issues.

TABLE 2.6-1

SUMMARY OF IMPACTS BY KEY ENVIRONMENTAL ISSUES

Key Environmental Issues	Alternative 1 Stansbury Project Plan	Alternative 2 Stansbury Project Plan with Mitigation Measures	Alternative 3 No Action
Water Quality and Sedimentation	Project development with designated sediment control measures and limited monitoring.	Project development with expanded monitoring program. Improved surface water control measures including inwardly draining mine pit and enlarged sediment pond.	No project; no additional activities to manage surface waters; some runoff and sedimentation continues from past mining and timber harvests in region until reclamation.
Wildlife Impacts	Project development with increased traffic and employee access; decreased elk security; improved habitat with reclamation.	Road closures and bussing of workers to increase elk security.	No project; reclamation will improve elk habitat and security.
Water Use	Proposed project plan assumes development of spring to yield 50 gpm, or 30,000 gal/day; potential adverse impacts to downstream users.	Development of on-site wells, provision for delivery of water from off-site via trucks, or purchase of surface water rights.	No project; no water development would occur.
Ground Water Availability, Levels, and Flow	Proposed plan does not contain ground water management program to address excess ground water in mine pit and possible dewatering of ABM Ridge, potentially causing wetlands impacts, slope instability, and surface water quality impacts.	Address ground water/surface water impacts from mine pit development through improved control measures during construction and operation, additional data collection and analysis, and monitoring.	No project; no ground water discharge problems experienced because mine pit is not excavated to level of current ground water flow.
Loss of Wetlands	Loss of wetlands experienced through filling and dewatering as a result of mine-related construction.	Proposed plan with mitigation would address wetlands issues through (a) relocation of soils stockpiles, (b) modification of sediment ponds, (c) replacement of lost wetlands, if necessary (d) elimination of road widening in wetlands areas, and, (e) relocation of mine buildings and facilities out of wetland areas .	No project; wetlands would remain in their present condition.
Public Health Risks	With proposed project development, health risks are estimated to be negligible.	No mitigation considered necessary.	No project; negligible increase in estimated health risks from project would not occur.
Transportation Impacts	Road improvements and maintenance would be performed as necessary.	Specified road improvements, maintenance, bussing and construction requirements would lessen impacts from dust and noise; and traffic safety would be improved.	Current limited use can be accommodated on existing roads if project is not constructed.

3.0 AFFECTED ENVIRONMENT

This chapter describes the current state of environmental resources potentially affected by the proposed project. The area of analysis for each resource is identified, and available baseline information for each resource is summarized. Baseline data for this section are extracted from information compiled by Stansbury Holdings Corporation for permit applications, agency studies, and other sources. Information presented in this chapter provides the basis for comparison of potential impacts which may be associated with the various alternatives.

Project area or project site refers to the area surrounding all project components -- mine, ore concentrator, sedimentation ponds, access roads, waste rock stockpile, and infrastructure elements. The proposed project area comprises a 139.2 acre mine permit area. About 77 acres of the mine permit area are proposed for surface disturbance. The project area is located in the Sapphire Mountains at an elevation of approximately 6,900 feet, and is entirely contained within the Bitterroot National Forest (BNF). Hamilton, Montana, is 11 miles west of the proposed mine site. The area is mostly forested, with steep slopes, many seeps, and scattered wetland areas. Two tributaries of the Bitterroot River, Willow Creek and St. Clair Creek, provide surface water drainage from the project area.

Public lands are managed by the BNF under the multiple use policies of the BNF Forest Plan. Timber harvesting, recreation, and wildlife habitat are the predominant land uses. A large number of recorded mining claims exist in the vicinity of the project area, primarily owned by Stansbury Holdings Corporation.

3.1 METEOROLOGY AND CLIMATE

Information regarding meteorology and climate is taken from the 1979 EIS/EA for the project (MDSL/USFS, 1979). The climate of the Bitterroot Valley is characterized by relatively mild winters, cool summers, light precipitation, and very little wind. Large daily and seasonal fluctuations in temperature are common.

Precipitation is considerably higher in the Bitterroot Mountains than in the Sapphire Mountains or the Bitterroot River Valley. The pattern of precipitation shows two maximums: one in May and June, which is characteristic of the Great Plains, and another in the fall, which is characteristic of the Pacific Northwest.

Forest Service personnel have estimated that the mine area receives 35-45 inches of precipitation annually. This amount of moisture is transformed into approximately 14 inches of runoff in a typical year.

Wind direction generally is from the southwest; wind speed is greater in the higher elevations. Less evaporation occurs at higher elevations during the year, but may occur at a greater rate during the summer months due to the effects of wind and increased solar radiation.

The following data characterize the Hamilton, Montana area:

Mean minimum temperature:	33.2°F
Mean maximum temperature:	59.2°F
Highest recorded temperature:	103.0°F
Lowest recorded temperature:	-39.0°F

Length of growing season:	130 days
Average date last killing frost:	May 16
Average date first killing frost:	September 23
Average annual precipitation:	12 inches

3.2 AIR QUALITY

The Bitterroot Valley has a north-south orientation with the Bitterroot and Sapphire Mountains rising more than 4,000 feet above the valley floor on each side. Since the predominant synoptic wind flow is westerly, these mountains tend to block the wind flow in the valley, preventing normal flushing action. Frequent low-level inversions also tend to trap air pollutants in the area. The inversions act as a lid on a box created by the valley walls. Any air pollutants emitted are trapped in the valley until the inversion is removed by solar heating or strong winds. Upslope and downslope winds caused by differential heating on the valley walls keep the air mixed below the inversion, but the air pollutants cannot escape until the inversion is broken. Normal nighttime downslope winds tend to collect pollutants in the valley bottoms. The potential for air pollution problems caused by meteorological conditions is greater during the fall and winter season. During these seasons, the decrease in solar heating hours and the reflection of solar insolation by snow cover reduce atmospheric mixing. Frequent high pressure systems during the fall-winter season cause inversions in this area to persist for several days at a time, during which any air pollutants emitted will continue to accumulate in the valley. During the spring and summer season, increased wind speeds and increased convective activity reduce the chance of air pollutants being trapped.

The air quality designation for the Hamilton and mining area, according to the prevention of significant deterioration (PSD) rules, is Class II. This designation allows for a modest increase in particulate, sulfur dioxide, and nitrogen dioxide levels. The designation does not, however, allow for growth beyond any ambient air quality standard. The Selway-Bitterroot Wilderness area located to the west of Hamilton is designated as a Class I area. This designation allows for essentially no measurable increase in ambient concentrations of the above referenced air pollutants.

Some ambient air quality monitoring has occurred in the Bitterroot Valley over the past decade. A total suspended particulate (TSP) monitor was operated at the Ravalli County Courthouse from 1983 to 1987 by the Montana Air Quality Bureau. The monitor was discontinued in 1987 due to state-wide priorities. The following data provide a summary of the results of that monitoring:

Year	Mean Concentration ($\mu g/m^3$)
1983	67
1984	60
1985	52
1986	55

These values compare to the ambient air quality standard of 75 micrograms per cubic meter ($\mu g/m^3$) which was in effect at the time. Since July 1, 1987, however, the Environmental Protection Agency (EPA) replaced this standard with a new standard which only measures particulate matter less than 10 microns in diameter (PM10). Based on this new standard, EPA and the Montana Air Quality Bureau have designated the Hamilton area as a Group III area. This designation means that there is a very low probability that the area exceeds the new PM10 standards.

No other measured ambient air quality is known for this area, including the mine site. It is reasonable to presume that actual ambient air quality levels for all other regulated pollutants (sulfur dioxide, nitrogen dioxide, ozone, carbon monoxide, and lead) are generally well below the ambient air quality standards. This presumption is based upon measured data in other Montana communities of similar size. Ambient air concentrations of unregulated pollutants in the Hamilton area, such as wood smoke, hydrocarbons, and other organics, are not known. Ambient air concentrations of asbestos are discussed in Section 3.4.

3.3 GEOLOGY AND MINERALS

GEOLOGIC SETTING

The Sapphire Mountains are a complex assemblage of folded and faulted Precambrian sedimentary rocks more than 600 million years old. These geologic units have been further complicated by several large granitic magma intrusions, including quartz monzonite. This area's structural complexity is a product of the Northern Rocky Mountain building processes, specifically, the intrusion of the Idaho Batholith and associated granitic stringers, and the subsequent sliding movement of the Sapphire Mountains.

The geology of the Western Vermiculite Project is indicative of the geology described above. The mine site lies at the extreme eastern margin of the Idaho Batholith in the Sapphire Mountains. The vermiculite-hydrobiotite ore occurs in a pyroxenite (dark colored igneous rock) intrusion. The pyroxenite-syenite body and associated dikes were emplaced into impure argillites and limestones of the mid-Proterozoic Wallace Formation of the Belt Supergroup.

ORE BODY CHARACTERIZATION

The Western Vermiculite pyroxenite deposit which contains the vermiculite ore is possibly lens- or pod-shaped. Other associated minerals are hornblende, metadiorite, magnetite, actinolite, anthophyllite, cummingtonite-grunerite, tremolite, sphene, apatite, and minor amount of tourmaline and titaniferous garnet. The vermiculite-hydrobiotite mineral to be mined occurs in scattered and concentrated forms within the pyroxenite body.

The actinolite in the surrounding country rock is a light green mineral with short, needle-like, radiating crystals. The actinolite within the ore body is dark green and occurs as densely packed "books" of long prismatic crystals. The actinolite within the ore body is surmised to occur in high angle to vertical dikes and stringers of sub-inch to approximately three-foot thickness. This judgment is based on surface expression of the actinolite and drill-core information (see sampling program discussion on following page).

Actinolite grade metamorphism is pervasive throughout the Wallace Formation in the Skalkaho area. Actinolite is indicative of a medium temperature (400-600°C) alteration of calcium-silicate based materials. This level of metamorphism is characteristic of regional zonation of metamorphism based on distance from the Idaho Batholith, which served as the primary heat source (Wallace et al., 1989; and LaTour, 1974).

PHYSICAL AND CHEMICAL PROPERTIES OF VERMICULITE

Vermiculite is a hydrated magnesium-aluminum-iron sheet silicate of variable composition. The crystal structure is similar to that of biotite mica. In biotite, potassium ions occupy regular sites which overlap corresponding sites in adjacent layers. The electronic charges of these ions help to hold the layers

together. In vermiculite, only some of the sites are occupied, and these only by magnesium, but a double layer of water molecules also is present in these inner layer regions.

Crude vermiculite denotes the mined ore that has been beneficiated and sized. The exfoliated product is also called vermiculite. The water content of vermiculite ranges from 4 to 14 percent. The process of exfoliation causes the bulk or sizes of vermiculite to expand from 8 to 12 times and yields a product with a density of 4 to 11 pounds per cubic foot. Exfoliation is accomplished by converting part of the water content of vermiculite into steam which forces the laminae apart at right angles to the cleavage planes to form an accordion-like product.

COMMERCIAL USES OF VERMICULITE

Uses of exfoliated vermiculite are numerous and diverse. The following discussion is derived from a report prepared for U.S. EPA (1985). Expanded vermiculite is completely noncombustible and maintains its thermal insulating value to upwards of 2,000°F making it particularly useful in refractories, fire bricks, and barbecue briquettes. The finer grades have an added advantage of higher thermal reflection of radiant heat. The structure lends itself to use as a component of blown insulation for dwellings and other construction. The high volume of expanded vermiculite makes it ideal as a filler material in gypsum wallboard, plaster, and concrete products. As an invert bulking agent, vermiculite is further utilized in pesticides, fertilizers, cattle feed, and hatchery and poultry litter.

Due to its porous quality, vermiculite is commonly used in household items such as potting soil and cat litter. On the outer extreme of its applications are its uses as a filtering media for waste water treatment and air purification, and as simulated dust and ashes in the movie industry. A market feasibility study will be released concurrent with this EIS by the U.S. Forest Service (USFS).

SAMPLING

The structure of the ore body was evaluated by standard methods of geologic sampling and analysis. The following information is summarized from USFS/DSL (1988). Both vertical and angled core samples were taken extending below the ore body throughout the proposed mine site on ABM Ridge. Four samples were taken at equal intervals to determine if actinolite was present within vertical vein systems. Cores recovered from drilling were indexed according to mineral content by visual definition. In the mineral industry, this process is known as core logging. The core sections were then split vertically along their entirety for easier handling. Each sample was then progressively crushed and screened by the agencies to provide a fine-grained useable sample. Four additional samples were taken directly from the dikes which were observed to possess the highest concentrations of actinolite. The crushed samples were divided into four equal parts, each of which was bagged, sealed, and identified for analysis. The samples were then shipped to the RJ Lee Group in Pennsylvania for mineral characterization and fiber content (1988a). A group of check samples was also sent to Environmental Testing and Technologies, Inc. (1988) in New Jersey for validation of the results from the RJ Lee Group.

The results of this sampling and analysis program indicate that, in addition to vermiculite and other minerals, the ABM Ridge ore deposit contains a variety of different amphibole minerals, including anthophyllite, cummingtonite-grunerite, tremolite, actinolite, and hornblende. Of these amphiboles, only actinolite and hornblende were shown to produce fibers after crushing and processing. Concentrations of actinolite fibers present in the ore range from non-detected to 0.5, expressed in terms of volume percent fibers greater than 5 microns, with an aspect ratio greater than 3:1. Hornblende fiber concentrations range from 0.01 to 0.65 volume percent fibers.

In terms of potential health effects, the mineral of primary interest in the ABM Ridge deposit is actinolite. Actinolite is the middle member of the tremolite-actinolite-ferroactinolite family. Tremolite is white in color, becoming green with increasing iron content (actinolite). Actinolite can exist in two mineral forms, one of which is related to asbestos. A textbook description of actinolite (Mason and Berry, 1968) states, "the amphibole mineral is usually found in aggregates of long prismatic crystals, sometimes fibrous and asbestiform; occasionally dense and fine-grained." It is important to point out, however, that the actinolite mineral present in the ABM Ridge deposit is not asbestos, and the health effects associated with asbestos exposure may not be the same for actinolite. Asbestos is a commercial industrial term which primarily refers to a group of serpentine (chrysotile asbestos) and amphibole (crocidilite asbestos and amosite asbestos) minerals which characteristically have long fibers that can be woven into strong heat-resistant fabric. Actinolite can exist in a form that is physically similar to asbestos but this form of actinolite is not generally believed to be present in the ABM Ridge ore deposit (see Appendix A for discussion of asbestos, actinolite, and health risks).

INDEPENDENT REVIEW OF DRILLING AND SAMPLING METHODS

The drilling and sampling methods used by Stansbury Holdings Corporation and the agencies to characterize the ore deposits and in particular, amphibole percentage composition of the ore body, have been submitted to three independent mining geologists for review. The experts selected were: Paul Pierce, Geologist, Western Field Operations, U.S. Bureau of Mines; Peter Knudsen, Professor of Geology, Head of Division of Mining and Minerals Engineering, Montana College of Mineral Sciences and Technology; and Ken Black, Mining Geologist, Camp, Dresser and McKee. These reviewers concluded that:

- spacing and number of drill holes for evaluation of the ore deposit are consistent with standard mineral exploration practices
- two angle holes appear to have intersected the primary calcite actinolite veins and are thus appropriate
- selection of cores throughout the deposit for mineralogical analysis, rather than a random selection procedure, is the correct approach to characterize amphibole content of the ore

It was also noted that although additional sampling could be performed for the ABM Ridge deposit to further characterize the location and distribution of amphibole minerals, it was believed that adequate characterization had already been achieved. Copies of their reports are available in the project files. (Black, 1990; Knudsen, 1990; and Pierce, 1990).

OTHER MINERALS

Scattered through the general area around the Western Vermiculite mine are small occurrences of gold, silver, lead, copper, molybdenum, and sapphires, all considered to be present in quantities and concentrations insufficient to warrant development.

OIL AND GAS

The oil and gas potential of the area surrounding the Western Vermiculite Mine is not well known. However, the potential for an oil and gas discovery is considered small because the geology is not very favorable.

GEOTHERMAL

The area has some potential for geothermal resources. Sleeping Child Hot Springs (surface temperature about 50°C), located about 12 miles southwest of the mine site, is indicative of the area's possible future geothermal power production potential. Given the present state-of-the-art in geothermal power generation, water temperatures of less than 90°C are not looked upon as economically feasible.

3.4 PUBLIC HEALTH RISKS

BACKGROUND

A major concern voiced by the public is the possibility of adverse health effects from asbestos released into the community during operation of the Western Vermiculite Project at ABM Ridge. It is important to state here that there is no asbestos in the ABM Ridge ore deposit. As noted in Section 3.3, asbestos is a commercial industrial term which is typically used to identify the three most common types of asbestiform minerals of commerce, namely chrysotile, crocidolite, and amosite. None of these minerals exist at the site. An amphibole mineral which can exist in a form that is related to asbestos and which is present at the site is actinolite. However, the form of actinolite present at ABM Ridge is not asbestiform, that is, it does not have the hairy, fibrous crystalline form of asbestos. There is very little health risk information available for actinolite, compared to the massive amount of information related to asbestos. For this reason, it is not possible to develop precise, quantitative estimates of potential health risks for actinolite exposure. Although a definitive and qualitative characterization of the potential health effects from exposure to this form of actinolite is not possible, it is likely that the health risks are less than those of asbestos (Brown, et al., 1984; Higgins, et al., 1981; Cooper, et al., 1988). Nevertheless, the assumption was made for the purposes of this EIS that the health risks of nonasbestiform actinolite exposure are the same as for asbestos, to ensure that health risks were not underestimated. This is a major assumption which may result in overestimation of potential health risks for the Western Vermiculite Project.

Potential health risks from exposure to amphibole minerals present in the ABM Ridge ore deposit are evaluated in this EIS by means of a Health Risk Assessment (HRA). An HRA is a technical evaluation which characterizes the nature and extent of health risks posed by sites, processes, or activities. The purpose of the HRA performed for the Western Vermiculite Project is to characterize the potential health risks from airborne amphibole minerals which could be released by several mine-related activities into the environment. Representative exposure scenarios, or conditions, were developed to evaluate a range of exposure possibilities.

Residential, recreational, and occupational exposure to actinolite from operation of the mine is possible. The Health Risk Assessment (HRA) performed as part of this EIS focuses on the potential health risks from residential and recreational exposure. Regulation of mine safety including occupational exposure to dusts and fibers is the responsibility of the Mine Safety and Health Administration (MSHA), and MSHA will regulate worker safety.

MSHA has promulgated standards for airborne asbestos fibers which would apply to the Western Vermiculite Project. The asbestos standards were developed based on previous epidemiology studies involving workers in the asbestos mining and milling industry, and are intended to maintain a safe and healthful working environment. If unsafe levels of airborne asbestos fibers occur at the mine (based on the results of MSHA's mandatory monitoring program) MSHA would determine appropriate emission controls for the mine site to bring the site into compliance with Federal standards. The current MSHA

standards for asbestos fiber exposure are 2 fibers/cc for long-term exposure (8 hour time weighted average) and 10 fibers/cc (acute exposure) (MSHA 30 CFR 56.5001).

EXPOSURE SOURCES

Residential and recreational exposure to actinolite and other amphibole fibers from the Western Vermiculite Project could occur during several types of mine-related activities. The primary potential source of amphibole exposure would likely be emission of amphibole-containing dust from ore extraction, ore handling, ore concentration, transport of waste rock, transportation of baghouse dust and tailings to stockpile areas, and road dust from roads paved with waste rock. Additional but minor sources of amphiboles could include fugitive dusts from ore concentrates during transportation to the exfoliation plant, exfoliation plant emissions and accidental spills of ore concentrate in traffic accidents.

IMPACT STUDY AREAS

In terms of potential affected environment, there are several geographic areas which should be considered. Five types of areas are evaluated in this EIS which can be considered as the impact study areas.

- The mine site is located on Forest Service land which is used for multiple activities, particularly hunting and recreation. In this case, exposure to mine-related dusts would be intermittent rather than constant, because these activities are sporadic and typically limited to a few days per year.

- Closest residence to the mine site. For the Western Vermiculite Project, the closest residence to the mine is located about 6 miles from the mine site. Exposure potential for residences in this area could be frequent and of extended duration.

- City of Hamilton is located 11 miles west of the proposed mine site and it represents another type of geographic area for potential amphibole exposure.

- Hypothetical traffic accident involving a truck carrying ore from the mine site to the exfoliation plant.

- Exfoliation plant in Butte. In contrast to the situation described above for Hamilton, residences are located considerably closer to the source of amphibole fibers. The exfoliation plant is outside the project area but is considered in this EIS as a connected action in the context of the HRA.

The geographic areas just described characterize the potential human receptors of amphibole fibers from air emissions associated with the Western Vermiculite Project. These areas differ from each other in terms of exposure amount, duration and frequency, as well as by size of the population potentially exposed.

CURRENT CONDITIONS

Very little data are available for ambient airborne concentration of actinolite or asbestos in the general area. The Montana Air Quality Bureau (1987) conducted limited air sampling for asbestos fibers in the ambient air. The samples were analyzed by both phase contrast microscopy by Northern Engineering, and transmission electron microscopy by Energy Technology Consultants (RJ Lee, 1988a). The phase contrast method is not able to distinguish between asbestos fibers and non-asbestos fibers, so some or all of the fibers reported by this measurement method may not actually be either asbestos or actinolite. The

transmission electron microscopy (TEM), on the other hand, can distinguish between the two and has a higher resolution. The results of these samples, which were collected in October, 1987, are shown below.

Sample Location	Phase Contrast all fibers	TEM amphibole fibers
County Shop	0.009	N.D.
Downtown Hamilton	0.005	N.D.
Hamilton Heights Road	0.005	N.D.
Interim Stockpile*	0.006	N.D.
Access Road (switchback)	0.006	0.01
Mine Site (ABM Ridge)	0.006	N.D.

Units = fibers/cc
*Interim stockpile refers to original permit application. No interim stockpile is currently under consideration.
N.D. - Not Detected; detection limit 0.006 fibers/cc

Only the TEM can be considered to reliably identify asbestos, and only one TEM sample was positive in this survey. The level of asbestos found in the single positive sample is only slightly above background and is not definitive.

Rural background concentrations of airborne asbestos typically range from 0.00002 - 0.00075 fibers/cc because there are asbestos fibers from both natural and manmade sources, such as car brakes, insulation products, and weathering of asbestos-containing rocks. Data describing current concentrations of airborne actinolite in the Hamilton area are not available. The air sampling data presented here are too limited to adequately characterize current ambient asbestos concentrations in the vicinity of the mine project or surrounding area.

3.5 HYDROLOGY

The proposed vermiculite mine site lies on, and adjacent to, ABM Ridge within the headwaters of St. Clair Creek. St. Clair Creek is a third order tributary of the Bitterroot River flowing westerly into Gird Creek from the Sapphire Mountains east of Hamilton, Montana. The project area includes a mine, ore concentrator, host rock waste stockpile (HRWS) and associated haul roads. Projected disturbance area totals 77 acres. At the HRWS area, a minor amount of disturbance (less than 5 acres) would occur within the Butterfly Creek drainage which is the tributary to Willow Creek. Willow Creek is tributary to the Bitterroot River.

Maximum elevation of the watersheds is 8,460 feet at Skalkaho Mountain. The total drainage area of St. Clair Creek and Butterfly Creek are 14.9 square miles and 3.1 square miles, respectively. The estimated average annual precipitation in the watersheds is about 35-45 inches with runoff estimated at 14 inches (U.S. Department of Commerce, 1973). Skalkaho Peak has an average annual precipitation of about 45 inches. About 4 feet of snow is common on the southerly aspects of the watersheds in winter. Snowmelt occurs approximately 10 percent in April, 60 percent in May, and 30 percent in June. Monthly percentages of annual runoff are 5 percent in March, 5 percent in April, 20 percent in May, 35 percent in June, 15 percent in July, and 5 percent in August with the remainder distributed evenly among the remaining months.

SURFACE WATER FLOW

Rainfall, snowmelt, and ground water discharge are the primary components of flow in the area under study. Snowmelt plays an important role during the spring and early summer with respect to the rise and fall of the runoff hydrograph. Similarly, ground water provides sustained recharge to the surface water system during late summer and fall via release of ground water stored within bedrock and unconsolidated surficial materials which are in hydraulic communication with the drainageways.

St. Clair Creek and Tributaries

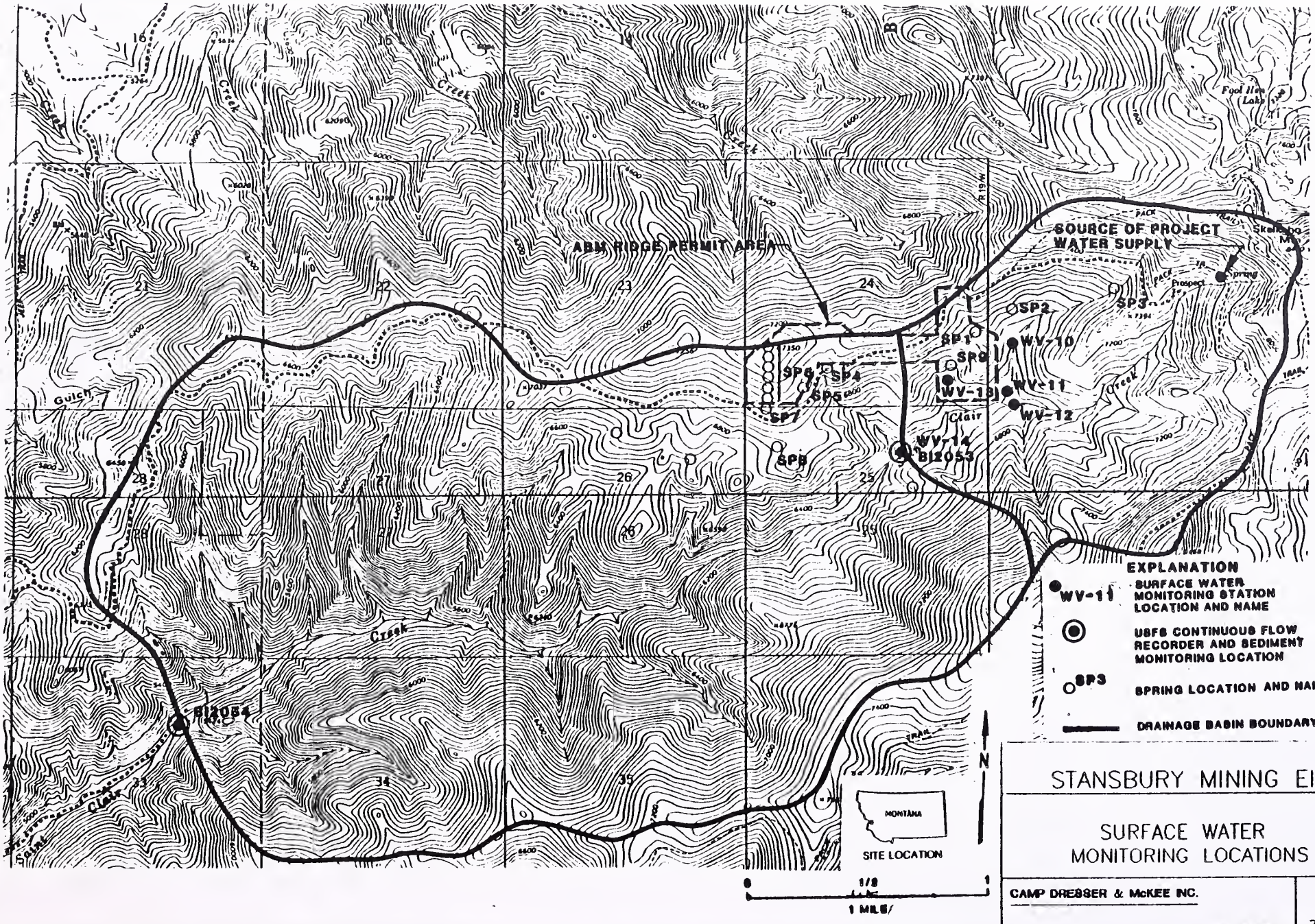
St. Clair Creek flows along the south side of the proposed mining project. The proposed mine site is bounded by tributaries on the east and west sides of the ABM Ridge, both of which contain wet meadows of limited areal extent (approximately 10 acres). The HRWS area also drains to St. Clair Creek, approximately one mile downstream from the mine site.

To establish baseline conditions, a stream flow and water quality monitoring program was implemented by both the USFS and the Stansbury Holdings Corporation. In the late 1970s, the USFS Bitterroot District established a monitoring station on St. Clair Creek at the forest boundary. The monitoring station, known as lower St. Clair Creek (EPA STORET #BI2054), was equipped in 1982 with a continuous recorder to monitor flow and peak runoff events. In 1983, an upstream continuous monitoring station known as upper St. Clair Creek (EPA STORET #BI2053) was also established. The exact location of each of these stations is presented in Figure 3.5-1. Drainage areas for each of the stations is 7.61 and 1.83 square miles, respectively.

Historic instantaneous flow data collected for upper and lower St. Clair Creek are presented graphically on Figure 3.5-2. Additional flow data are presented in Table 3.5-1. Flow at the upper St. Clair Creek monitoring station ranges between 1 and 6 cubic feet per second (cfs). Peak flows due primarily to snowmelt runoff generally occur in late May/early June. Baseflow at this location is approximately 1.5 cfs. Channel width is approximately 4 feet. Flow at the lower St. Clair Creek monitoring station is notably higher, ranging between 3 and 45 cfs. Baseflow at this location is approximately 5 cfs. Channel width is approximately 9 feet. It is important to note that the years for which flow data were collected at these stations, snowpack and precipitation were below normal, with only 1982 and 1984 being considered average years. For the period of record, neither snowpack nor rainfall were above normal.

In 1987, Stansbury Holdings Corporation initiated a monitoring program for the vermiculite mine site in coordination with the Forest Service program. Stansbury monitored flow and quality on October 13, 1987 at stations WV-11,12,13, and 14. Station locations are shown in Figure 3.5-1. Station WV-14 is the same as the Forest Service upper St. Clair Creek station. In August 1990, Stansbury reactivated this monitoring program and also established an additional monitoring station, WV-10, located above mining-related impacts on the tributary to St. Clair Creek east of ABM Ridge. Station WV-12 is located on the mainstem of St. Clair Creek above all mining-related impacts from the proposed project. The station is located downgradient of Horse Ridge, an area proposed for potential future development of vermiculite reserves. Horse Ridge is not part of the Proposed Action under evaluation in this EIS, but is considered under cumulative impacts.

Flow at Station WV-12 was 1.25 cfs on August 13, 1990; in October, 1987, flow was 0.77 cfs. These values are consistent with baseflows recorded downstream at the upper St. Clair Creek monitoring station. Flow data collected at stations WV-10 and WV-11 on the St. Clair Creek tributary located on the east side of ABM Ridge indicate a baseflow ranging between about 0.1 and 0.2 cfs in a 2-foot wide channel. Same-day flow data in 1990 also indicate that the drainage loses approximately 0.1 cfs to the subsurface



STANSBURY MINING EIS

SURFACE WATER MONITORING LOCATIONS

CAMP DRESSER & McKEE INC.

CDM

FIGURE 3.5-1

SOURCE: STANSBURY HOLDINGS, 1990 a.

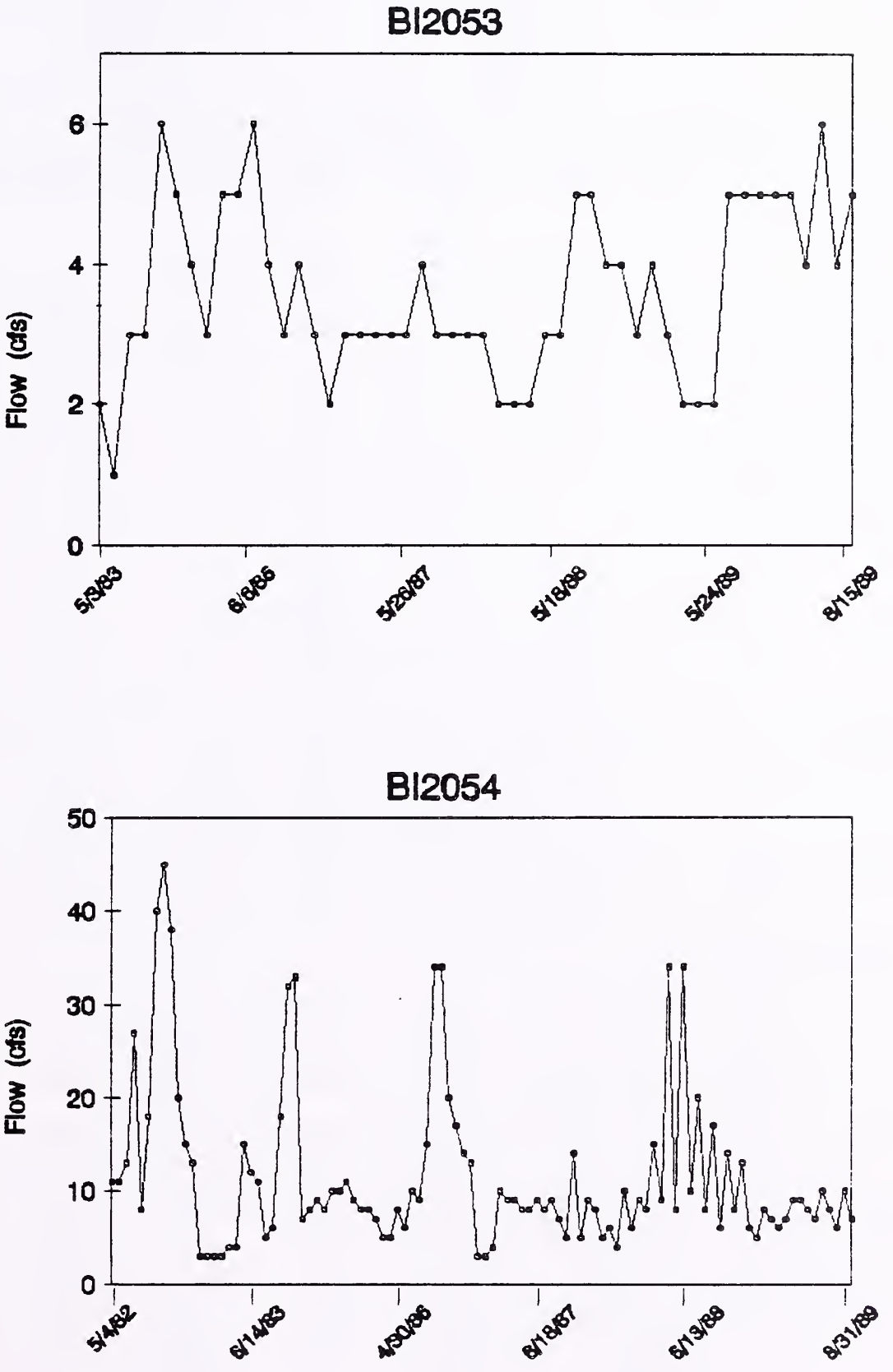


Figure 3.5-2 Instantaneous Flow Hydrographs for Upper and Lower St. Clair Creek, Stations B12053 and B12054

SOURCE: HAMMER, 1990.

TABLE 3.5-1

SURFACE WATER QUALITY DATA SUMMARY

Drainage:	ABM Ridge East			St. Clair Creek		ABM Ridge	
	Upstream	Downstream		Above Mine		West	
Station ID:	WV-10	WV-11		WV-12		WV-13	
(Equivalent ID):		(002)		(001)		(003)	
Parameter Date:	8/13/90	10/13/87	8/13/90	10/13/87	8/13/90	10/13/87	8/13/90
Specific Conductance (umho/cm)		136		121		295	
Flow (cfs)	0.22	0.2	0.09	0.771	1.25	<0.05	0.009
pH (standard units)	7.84	7.3	7.93	7.1	7.99	7.2	8.12
Total Phosphorus (mg/L)	0.0263		0.0212	<0.01	0.121		0.0517
Nitrate/Nitrite Nitrogen (mg/L)	0.05		0.01	<0.05	0.003		0.002
Silica (mg/L)	10.39		9.81		9.38		10.25
Total Suspended Solids (mg/L)	2.6	4	0.6	3	1	11	3.2
Total Dissolved Solids (mg/L)	4	134		110		199	
Major Cations (mg/L)							
Calcium	19.96	21	19.59	18	16.51	47	38.57
Magnesium	3.667	4	3.685	4	3.032	10	8.618
Sodium	0.92	1	0.995	<1	0.884	1	1.455
Potassium	2.05	2	2.4	1	1.33	6	5.65
Major Anions (mg/L)							
Bicarbonate (as HCO_3)	73.6	70.0	71.9	61.0	58.9	179.0	163.5
Chloride	0.4	<1	0.3	<1	0.3	1.0	0.2
Sulfate	<1.0	6.0	<1.0	6.0	<1.0	1.0	<1.0
Total Alkalinity (as $CaCO_3$)	60.3	58.0	58.9	50.0	48.3	147.0	134.0
Flouride	0.1		0.1		0.1		0.1
Total Recoverable Metals (mg/L)							
Aluminum	<0.007	0.6	<0.007	0.6	<0.007	0.9	<0.007
Arsenic	<0.05	<0.005	<0.05	<0.005	<0.05	<0.005	<0.05
Cadmium	<0.0008	<0.01	<0.0008	<0.01	<0.0008	<0.001	<0.0008
Copper	0.001	<0.01	<0.0009	<0.01	<0.0009	<0.01	<0.0009
Iron	0.005	0.06	0.001	0.03	0.001	1.19	0.011
Lead	<0.05	<0.01	<0.05	<0.01	<0.05	<0.01	<0.05
Manganese	0.0007	<0.02	0.0001	<0.02	<0.0005	0.22	0.0054
Mercury	0.004	<0.001	0.002	<0.001	0.001	<0.001	0.006
Nickel	<0.05	<0.03	<0.05	<0.03	<0.05	<0.03	<0.05
Selenium		<0.005		<0.005		<0.005	
Silver		<0.005		<0.005		<0.005	
Zinc	0.0006	<0.01	<0.0008	<0.01	<0.0008	<0.01	<0.0008

Source: Stansbury Holdings Corporation, 1990a and 1990b.

TABLE 3.5-1 (Cont'd)

SURFACE WATER QUALITY DATA SUMMARY

Drainage:	Upper St. Clair Creek						Willow Creek	
Station ID: (Equivalent ID)	WV-14 (004) (B12053)							
Parameter Date:	6/8/78	8/23/78	5/29/79	10/18/79	10/13/87	8/13/90	5/26/74	5/28/74
Specific Conductance (umho/cm)	81.1	119.4	94		125		168.0	144.0
Flow (cfs)					2.334		9.92	23.7
pH (standard units)	8.39	7.8	7.31	7.77	7.2	8.07	7.80	7.75
Total Phosphorus (mg/L)					<0.01	0.0126	0.02	0.04
Nitrate/Nitrite Nitrogen (mg/L)					<0.05	<0.10	<0.10	0.3
Silica (mg/L)	16.3	19.4	17.4	20.3		9.69	16.7	14.2
Total Suspended Solids (mg/L)					1	1		
Total Dissolved Solids (mg/L)	81.4	111.6	91.2	118.67	118		151.8	136.4
Major Cations (mg/L)								
Calcium	11.2	16.3	13.5	16.8	19	16.85	29	26
Magnesium	2.4	3.1	2.8	3.8	4	3.142	2.3	2.4
Sodium	0.8	0.9	0.8	1.1	<1	0.902	1.5	1.4
Potassium	1.7	1.8	1.9	2.6	2	1.66	1.3	1.3
Major Anions (mg/L)								
Bicarbonate (as HCO_3)	42.7	64.7	49.5	67.6	64.0	61.7	91.0	86.0
Chloride	0.4	<0.15	0.45	0.35	<1	0.35	0.7	0.7
Sulfate	4.6	5.3	4.7	6.0	6.0	1.1	9.4	4.2
Total Alkalinity (as $CaCO_3$)	37.0	53.0	41.0	55.4	52.0	50.6	74.0	70.0
Flouride				0.1		0.07		
Total Recoverable Metals (mg/L)								
Aluminum					0.6	0.006		
Arsenic					<0.005	<0.05		
Cadmium					<0.001	<0.0008		
Copper					<0.01	0.0008		
Iron	0.01	0.02	0.01	<0.002	0.04	0.001	0.08	0.04
Lead					<0.01	<0.05		
Manganese	<0.01	<0.01	<0.01	<0.01	<0.02	<0.0005	<0.0005	<0.0005
Mercury					<0.001	<0.005		
Nickel					<0.03	<0.05		
Selenium					<0.005			
Silver					<0.005			
Zinc					0.01	<0.0008		

Source: Stansbury Holdings Corporation, 1990a and 1990b.

between the two monitoring stations. On the tributary to the west side of ABM Ridge, flow data collected at station WV-13 indicate a baseflow of less than 0.1 cfs in a one-foot wide channel. Due to the limited amount of flow monitoring data collected to date for all of these tributaries, the seasonal nature of the flow regime within each of these tributaries has not yet been determined. Additional periodic monitoring conducted during the rising and falling limbs of the spring and early summer runoff hydrograph will provide these data.

Butterfly Creek

As previously mentioned, a minor amount of disturbance associated with the HRWS area drains into the Butterfly Creek drainage. Within its headwaters, Butterfly Creek is ephemeral. Bankfull width of Butterfly Creek at its confluence with Willow Creek is 5 feet; bankfull flow is estimated at 2 cfs. No flow data are available on Butterfly Creek.

Springs and Seeps

During 1987 and 1990, springs and seeps were identified in areas within and adjacent to the proposed Western Vermiculite Project. Spring locations from the surveys are displayed on Figure 3.5-1. Springs inventoried during 1990 are numbered.

During the 1987 spring survey, springs were noted on the east and west sides of ABM Ridge. The spring on the immediate east side of ABM Ridge (Spring 1), located at the head of a small wetland, was estimated to be flowing at 20-30 gallons per minute (gpm) in May 1987 and believed to be perennial. The spring to the west of ABM Ridge (Spring 9), also located at the head of a small wetland, was difficult to measure for flow because of snow conditions and flow distribution at the time (May 1987), but was estimated at 10-20 gpm.

In the vicinity of the HRWS area, no springs were observed within 0.25 mile downgradient of the Butterfly Creek drainage side of the pile (north side of pile). In addition, the drainages inspected were heavily timbered and ephemeral in their upper reaches. Within the HRWS area itself, two seeps flowing less than 1 gpm were discovered after slash burning of the clear-cut in the fall of 1987. Additional springs were located below the HRWS area, as noted on Figure 3.5-1.

At the time of the initial inventory, springs and seeps in the vicinity of the project area were believed to be points of discharge from shallow, perched water-bearing zones in weathered and fractured surficial materials overlying bedrock. Observations of vegetation types and soil materials on road cuts indicated that water-bearing zones appeared to be limited to drainage areas immediately above points of discharge. Additional data collected indicated that this may be true for some of the springs but that most of the springs likely issue from a fault/fracture-controlled bedrock ground water system (see 1990 spring inventory results below and discussion on ABM Ridge ground water).

A second spring inventory within and adjacent to the ABM Ridge Project permit boundary was conducted on August 13 and 15, 1990 by Stansbury Holdings Corporation. At each spring location, spring elevation and flow were estimated. The geologic and geographic setting of each spring was also described as best as possible at each location and the source for each spring was conjectured. A summary of collected data is presented in Table 3.5-2 .

Nine springs were identified during the 1990 survey, all of which are believed to be perennial in that they were flowing during the baseflow portion of the year. Spring flow ranged from less than 1 to 5 gallons per minute (gpm). Only Springs 3, 8 and 9 flowed greater than 1 gpm. The geologic source of the

TABLE 3.5-2

SPRING AND SEEP INVENTORY RESULTS, 1990

Spring	Elevation (ft-amsl)	Flow (gpm)	Description
1	6,940-7,000	0.6	Spring forms a marshy area on hillside. Surface flow at base of marsh is small fraction of total water in system. Spring originates from a perched(?) water table in unconsolidated material overlying pyroxenite bedrock.
2	7,000	< 1	Spring forms a marshy area on hillside. Geologic setting is unknown but possibly related to contact between syenite and pyroxenite.
3	7,160	< 1	Spring forms headwaters of stream channel. Geologic setting is unknown but probably originates from a fault/fracture system in pyroxenite.
4	7,040	1-2	Springs are at roadcut and in marshy area below road. Roadcut spring flows 2 gpm; a spring below the road flows 1 gpm. Origin is believed to be perched water in unconsolidated material overlying syenite bedrock.
5	7,040	< 1	Same geologic setting as Spring 4. A diffuse seep is present at the roadcut, including several wet but not flowing areas below the road between Springs 4 and 5.
6	7,000-7,200	< 1	Six separate springs flowing < 1 gpm each are aligned along a slight swale on the hillside. Springs probably originate from a fault/fracture zone in syenite bedrock.
7	7,000	1	Seep was measured below the road and originated from perched water in unconsolidated material overlying syenite bedrock.
8	6,840	2.5	Spring forms a channel in a marshy saddle area. Geologic setting is probably a fault or contact between pyroxenite and syenite.
9	6,800-6,880	3-4	Spring originates in marshy area which is headwaters of tributary to St. Clair Creek. Geologic setting is probably a fracture zone in pyroxenite bedrock. A water quality sample (WV-13) was taken 8/13/90.

Source: Stansbury Holdings Corporation, 1990a and 1990b.

Notes: All flow measurements were performed by recording the time it took to fill a container of known volume.

springs was variable, ranging from glacial material overlying pyroxenite or syenite bedrock (Springs 1, 4, 5 and 7), to possible fault/fracture zones in syenite/pyroxenite bedrock (Springs 3, 6, 8, and 9), to unknown, but possibly related to the contact zone between syenite and pyroxenite (Spring 2). Spring 9, located to the west of ABM Ridge at the head of the wet meadow is also the same location as surface water sampling location WV-13. Water quality for this spring site is discussed under Surface Water Quality. No water quality data are available for any of the other inventoried springs.

SURFACE WATER QUALITY

St. Clair Creek and Tributaries

Surface water quality data collected along the mainstem of upper St. Clair Creek at Station WV-14 (BI2053) since the late 1970s are presented in Table 3.5-2. Water quality data for the tributaries to St. Clair Creek located on the east and west sides of ABM Ridge are also presented. A trilinear plot of the major cations and anions for each sample including a tabulation of total dissolved solids (TDS) concentrations is presented in Figure 3.5-3.

St. Clair Creek and its tributaries have excellent water quality. Calcium and bicarbonate are the major cation and anion in the water. Total dissolved solids concentrations range between 100 and 200 mg/L. Metals concentrations are generally below detection limits. None of the parameters exceed primary or secondary drinking water standards. Total suspended solids for the full suite of water quality samples, shown in Table 3.5-1, are low, ranging from less than 1 to 11 mg/L. Further discussion of stream sediment is presented under Sedimentation.

There are insufficient data to establish background concentrations of amphibole fibers in St. Clair Creek under different environmental conditions. See page 4-12 for discussion of a sample that was taken.

Butterfly Creek

Butterfly Creek is a significant tributary to Willow Creek. The two samples of water quality documented for this watershed are on Willow Creek. Table 3.5-1 summarizes these data. Willow Creek is very similar to St. Clair Creek, having excellent water quality, a low TDS and a calcium-bicarbonate type.

SEDIMENTATION

Due to the potential of timber harvests, mining operations, roads, and fires to affect sediment yields within the upper St. Clair drainage basin, the BNF has been periodically monitoring suspended and bedload sediment since 1982 along St. Clair Creek at monitoring locations BI2053, upper St. Clair Creek, and BI2054, lower St. Clair Creek, located at the Forest Service boundary (see Figure 3.5-1). The primary purpose for establishing these stations was to determine long-term baseline conditions in order to be able to quantify and/or predict any potential impacts to water quality, stream channel stability, fisheries, and aquatic habitat.

Sediment data collected to date are summarized in Table 3.5-3. A graphical plot of instantaneous flow and mean daily total suspended solids (TSS) concentration over time is provided in Figure 3.5-4. On upper St. Clair Creek, TSS concentration range between 0 and 5 mg/L throughout the year. However, during peak runoff events due to snowmelt or thundershowers, TSS concentrations occasionally exceed 5 mg/L. Only once in the spring of 1985 did TSS exceed 10 mg/L with a mean daily concentration of 24 mg/L. On lower St. Clair Creek, where baseflows are generally more than two times greater than

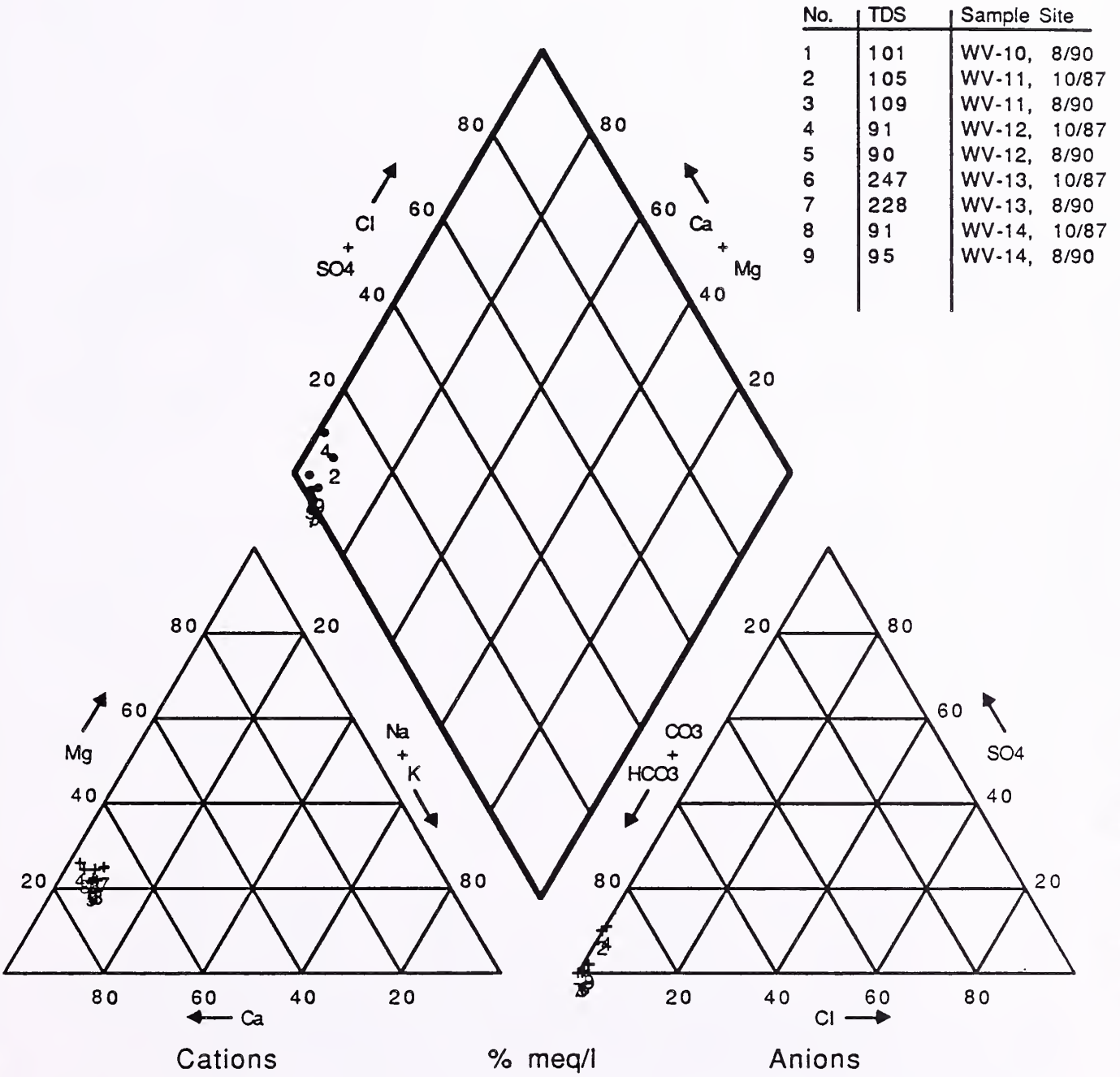


Figure 3.5-3 Trilinear Plot of Surface Water Quality Data

SOURCE: STANSBURY HOLDINGS CORPORATION, 1990b.

TABLE 3.5-3

SUMMARY OF SEDIMENT YIELDS, ST. CLAIR CREEK
1982 THROUGH 1989

	Station ID	Watershed Area (mi^2)	Water Year (days of record) 1982	1983	1984	1985	1986	1987	1988	1989
Upper St. Clair Creek	BI2053	1.83	(-)	(-)	(-)	(-)	(-)	(70)	(91)	(84)
Flow, Instantaneous (cfs)			-	-	-	2.9-6.2[a]	-	1.70-3.57	1.68-4.93	2.18-5.63
Flow, Peak Instantaneous (cfs)			-	-	-	9.8	-	-	-	-
Suspended Sediment Load (tons/mi^2)			-	-	-	3.18[b]	-	0.352	0.94	1.19
Max. Suspended Sediment (mg/l)			-	-	-	24.4	-	3.6	8.4	6.0
Bedload (tons/mi^2)			-	-	-	0.07[b]	-	0.154	4.80	-
Total Load (tons/mi^2)			-	-	-	1.81[b]	-	0.506	5.74	-
Lower St. Clair Creek	BI2054	7.61				(-)	(91)	(84)	(98)	(98)
Flow, Instantaneous (cfs)			10.5-48.0[a]	<10-21.5[a]	2.1-39.6[a]	2.5-13.7[a]	4.7-36.5	3.22-9.59	4.45-13.9	5.55-9.69
Flow, Peak Instantaneous (cfs)			56.5	-	46.2	16.7	41.8	-	-	-
Suspended Sediment Load (tons/mi^2)			-	-	-	0.64[b]	2.63	0.499	1.46	1.15
Max. Suspended Sediment (mg/l)			46.8	-	22.4	8.4	14.4	5.2	18.8	14.0
Bedload (tons/mi^2)			-	-	-	0.02[b]	0.31	0.156	4.37	-
Total Load (tons/mi^2)			6.3[b]	2.0[b]	4.05[b]	0.66[b]	2.94	0.655	5.83	-
General Comments										
Snowpack			average	low	average	very low	low	low	very low	low
Rainfall			average	low	average	very low	low	low	very low	low

Source: Hammer, 1990.

[a] Minimum and maximum daily flow
[b] tons/mi^2/yr
- Insufficient or lack of data

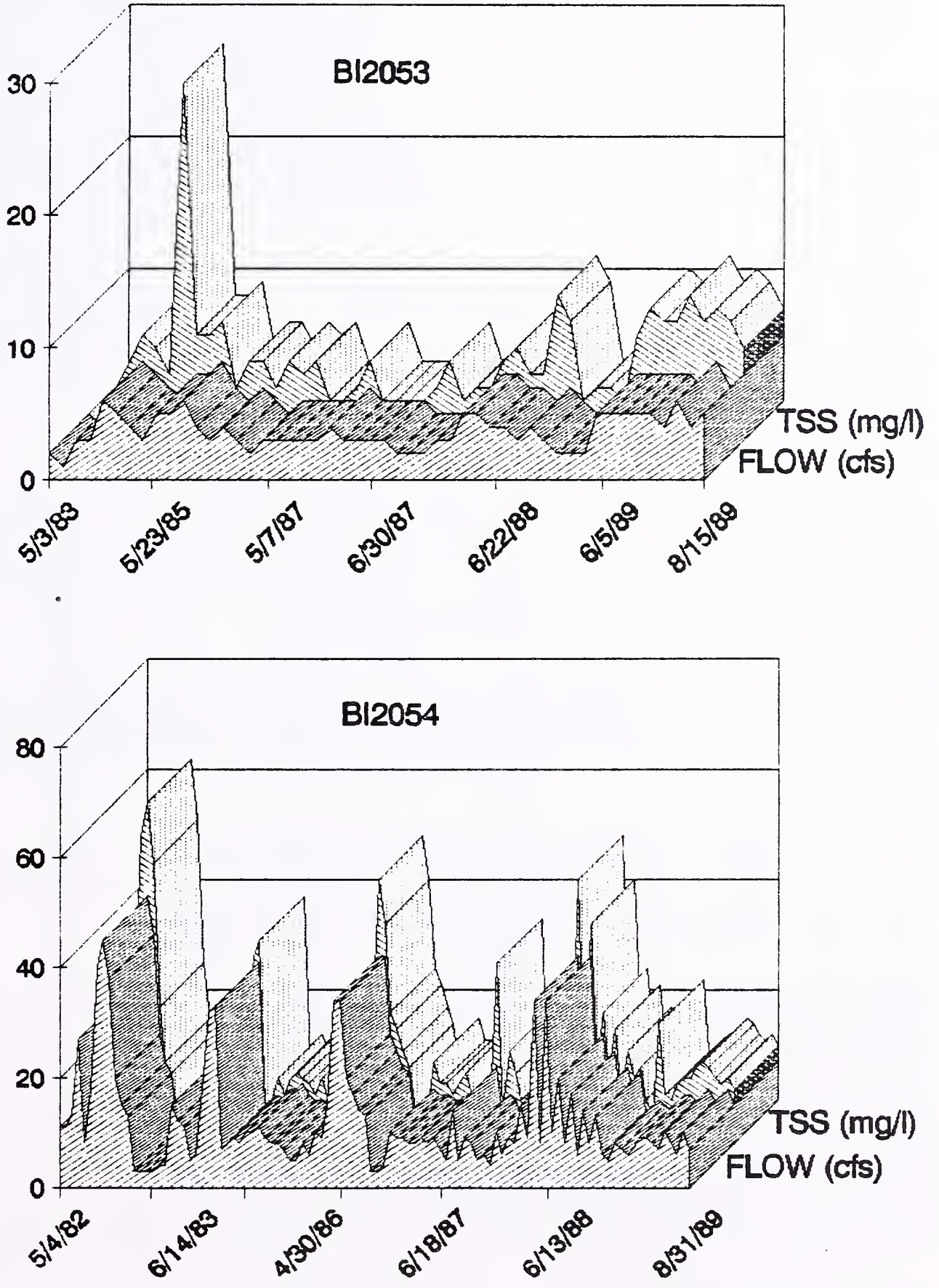


Figure 3.5-4 Upper and Lower St. Clair Creek Stream Flow Compared to Total Suspended Solids Concentration

SOURCE: STANSBURY HOLDINGS CORPORATION, 1990b.

upper St. Clair Creek, suspended sediment concentrations generally range between 1 and 6 mg/L. Occasionally, during high flows, sediment concentrations have approached 20 mg/L.

In addition to suspended sediment data, bedload data from each of the monitoring stations have also been collected. Three years of data are available for upper St. Clair Creek and four years for lower St. Clair Creek. The range in bedload values varies greatly for the period of record with values for both stations generally falling between 0.1 and 6.0 tons per square mile (tons/mi^2). This extreme variability may be due to the natural variability of the system, monitoring limitations, or a combination of the two.

Comparison of upper and lower St. Clair Creek baseline sediment data (see Figure 3.5-4) do not appear to show any obvious water quality effects of forest management. In addition, snowpack and rainfall for the period of record were generally well below average for most years. As a result, stream flow was below normal and little energy was available to move sediment except during rapid snowmelt and major precipitation events.

GROUND WATER AVAILABILITY, LEVELS, AND FLOW

The 1979 Draft EIS/EA prepared by DSL and the USFS described ground water resources of the proposed mining area based on regional studies by the Montana Bureau of Mines, geology of the area, and an unpublished report by the MDHES. In summary, ground water in the area occurs only in limited quantities in localized fractures and fault zones. Subsequent literature review by Stansbury Holdings Corporation revealed no new source of ground water data for the area. To date, no ground water resources in the area of the proposed mine have been developed.

Stansbury geologists reviewed the drilling logs and drillers' shift reports for all drilling done on ABM Ridge during exploratory investigations. Ground water was apparently not encountered at any drill sites on ABM Ridge. Subsequent observations of open drill holes on ABM Ridge in 1987 did not reveal any ground water. Observations conducted during the summer of 1990, however, did indicate the presence of ground water on ABM Ridge.

Table 3.5-4 summarizes water level data collected from a number of boreholes which were still accessible for water level measurement during July and August 1990. Of the 14 boreholes accessed, 12 contained water believed to be representative of static ground water conditions in that subsequent measurements did not indicate any influence from possible surface water runoff down the borehole.

Ground water elevations for boreholes monitored in late August 1990 are plotted on Figure 3.5-5. From these data, a piezometric (hydraulic grade line) surface map of the ground water table was constructed. Piezometric contours are generally conformable to the topographic expression of ABM Ridge. As a result, ground water flow directions generally conform to surface water flow direction. Ground water along the ridge generally ranges from 10 to 80 feet below ground surface. The relationship of ground surface to piezometric surface is graphically displayed in Figure 3.5-6, a north-south hydrogeologic cross section of ABM Ridge. Borehole water level measurements over a two-month time period indicate a steady decline in water level. Hydrographs for these boreholes are presented in Figure 3.5-7. Water level declines range from 3 to 20 feet for the period of record. These rapid changes indicate the rapid release of ground water to the surface water system and the direct role that spring snowmelt has on annually recharging the bedrock system.

Ground water along ABM Ridge likely occurs in fractures (joints or faults) in the vermiculite and bedrock. The bedrock in the mine area is generally highly fractured at the surface, decreasing with depth. The fractured bedrock system where it is overlain by unconsolidated valley-fill materials occurring

TABLE 3.5-4

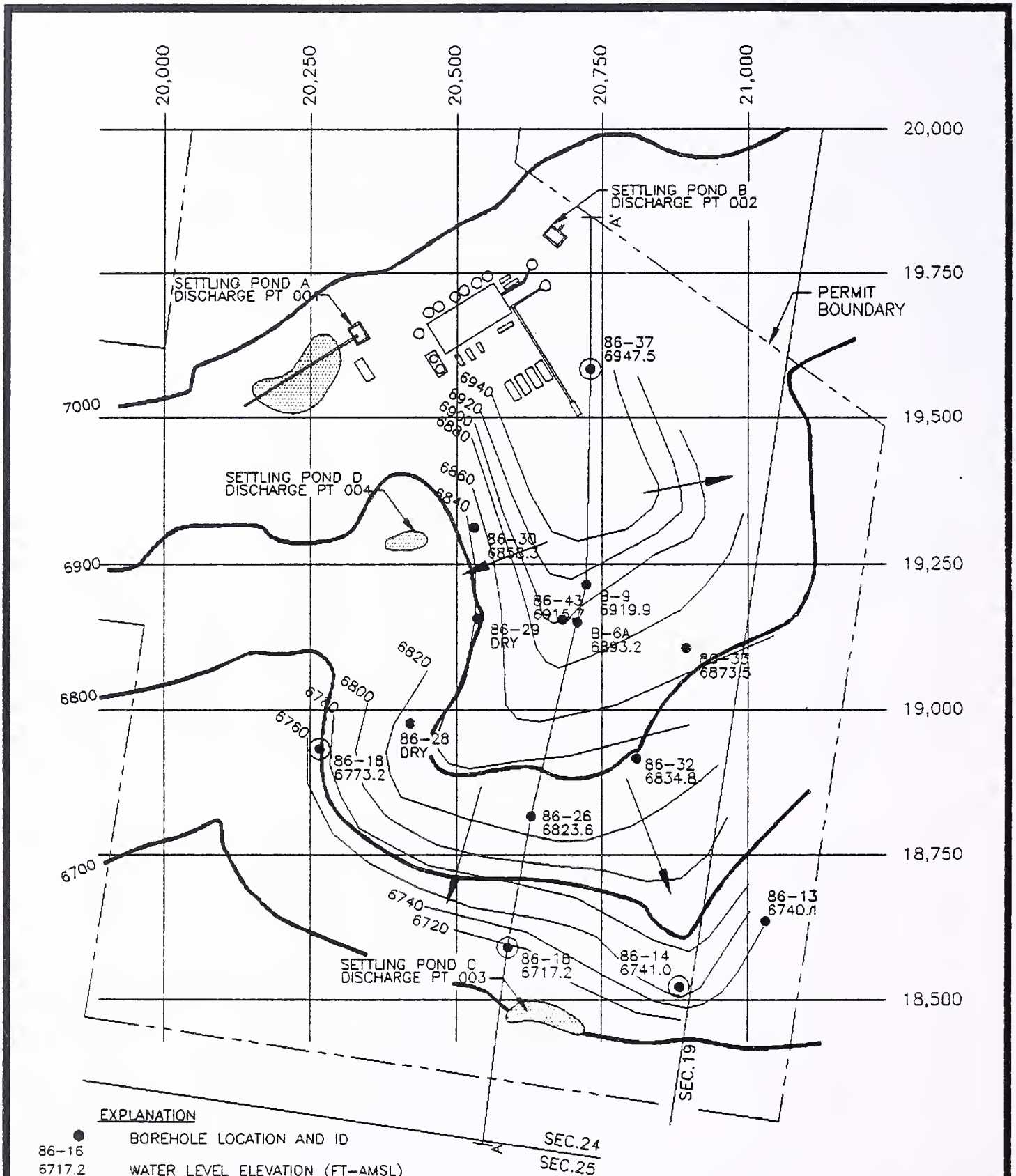
GROUND WATER LEVEL DATA SUMMARY
JULY AND AUGUST, 1990

Borehole No.	Depth to Water (ft)	Present Hole TD (ft)	Drilled Hole TD (ft)	Collar Elevation (ft-amsl)	Water Elevation (ft-amsl)	Pres. TD Elevation (ft-amsl)	Drill TD Elevation (ft-amsl)	Date Measured
B-6A	40.14	60.15	91.5	6942.0	6901.9	6881.9	6850.5	July 12, 1990
	43.55				6898.5			July 26, 1990
	44.60				6896.0			July 31, 1990
	46.00				6896.0			August 7, 1990
	48.85				6893.2			August 28, 1990
B-9	15.70	32.10	56.0	6950.9	6935.2	6918.8	6894.9	July 12, 1990
	16.07				6934.8			July 13, 1990
	18.25				6932.7			July 26, 1990
	19.10				6931.8			July 31, 1990
	20.30				6930.6			August 7, 1990
	34.05				6916.9			August 28, 1990
86-11	27.15	52.25	60.0	6777.1	6750.0	6724.9	6717.1	August 28, 1990
86-13	21.25	27.80	29.0	6761.3	6740.1	6733.5	6732.3	August 28, 1990
86-14	17.25	44.15	45.0	6753.2	6741.0	6709.1	6708.2	August 28, 1990
86-16	28.95	52.25	55.0	6746.1	6717.2	6693.9	6691.1	August 28, 1990
86-18	18.65	19.95	36.0	6791.8	6773.2	6771.9	6755.8	August 28, 1990
86-26	33.55	36.75	57.0	6857.1	6823.6	6820.4	6800.1	August 28, 1990
86-28*	Dry	-	51.0	6869.4	Dry	-	6818.4	July 12, 1990
86-29	Dry	30.5	62.0	6895.5	Dry	6865.0	6833.5	July 12, 1990
86-30	56.50	+100	113.0	6917.7	6861.2	-	6804.7	July 12, 1990
	58.20				6859.5			July 31, 1990
	58.65				6859.1			August 7, 1990
	59.45				6858.3			August 28, 1990
86-32	55.30	69.30	76.0	6898.3	6843.0	6829.0	6822.3	July 13, 1990
	60.30				6838.0			July 31, 1990
	61.50				6836.8			August 7, 1990
	63.55				6834.8			August 28, 1990
86-33	37.60	49.80	62.0	6913.5	6875.9	6863.7	6851.5	July 13, 1990
	40.01				6873.5			August 28, 1990
86-37	19.73	31.30	68.0	6969.2	6949.5	6937.9	6901.2	July 13, 1990
	20.85				6948.4			July 31, 1990
	21.75				6947.5			August 28, 1990
86-43	27.48	76.24	80.0	6947.1	6919.6	6870.9	6867.1	July 12, 1990
	28.90				6918.2			July 26, 1990
	29.30				6917.8			July 31, 1990
	29.88				6917.2			August 7, 1990
	31.45				6915.7			August 28, 1990

Source: Stansbury Holdings Corporation, 1990b.

*86-28 partially blocked at 4 ft; no sound of water with dropped rocks

ft-amsl = feet - above mean sea level



EXPLANATION

- 86-16 — BOREHOLE LOCATION AND ID
- 6717.2 — WATER LEVEL ELEVATION (FT-AMSL)
- 6700 — PIEZOMETRIC SURFACE CONTOUR (FT-AMSL)
- 7000 — TOPOGRAPHIC SURFACE CONTOUR (FT-AMSL)
- GROUND WATER FLOW DIRECTION
- BOREHOLE WATER QUALITY SAMPLE LOCATION
- A-A' — CROSS-SECTION

SOURCE: STANSBURY HOLDINGS, 1990 a & b

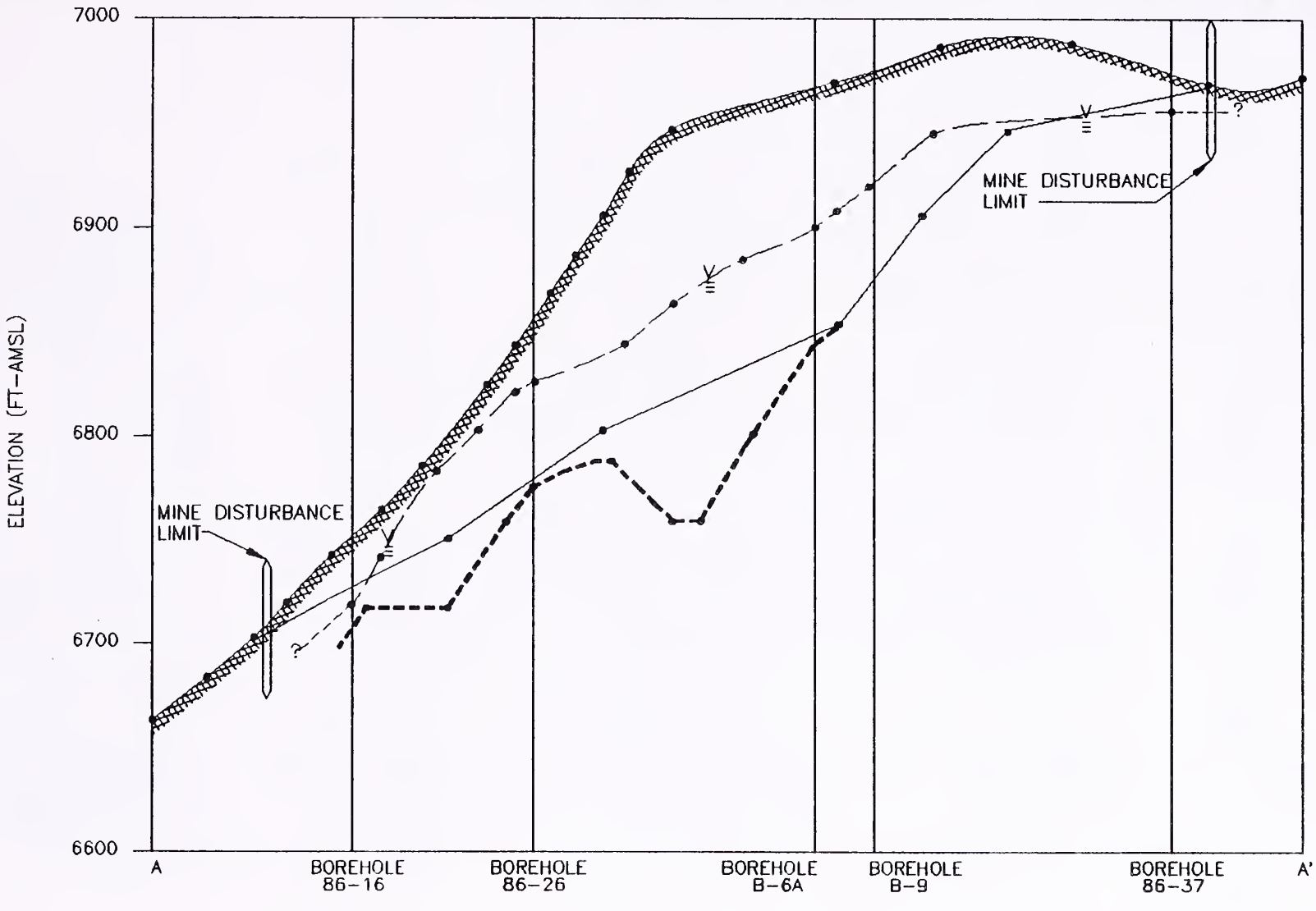
STANSBURY MINING EIS

PEIZOMETRIC SURFACE, AUGUST 1990, WESTERN VERMICULITE PROJECT

CAMP DRESSER & McKEE INC.

CDM

FIGURE 3.5-5



EXPLANATON

- GROUND SURFACE
- PIEZOMETRIC SURFACE (APPROXIMATE)
- RECLAIMED SURFACE (APPROXIMATE)
- MINED SURFACE (APPROXIMATE)

SOURCE: STANSBURY HOLDINGS, 1990 a & b

STANSBURY MINING EIS

HYDROGEOLOGIC CROSS-SECTION (A-A') OF ABM RIDGE

CAMP DRESSER & McKEE INC.

CDM

FIGURE 3.5-6

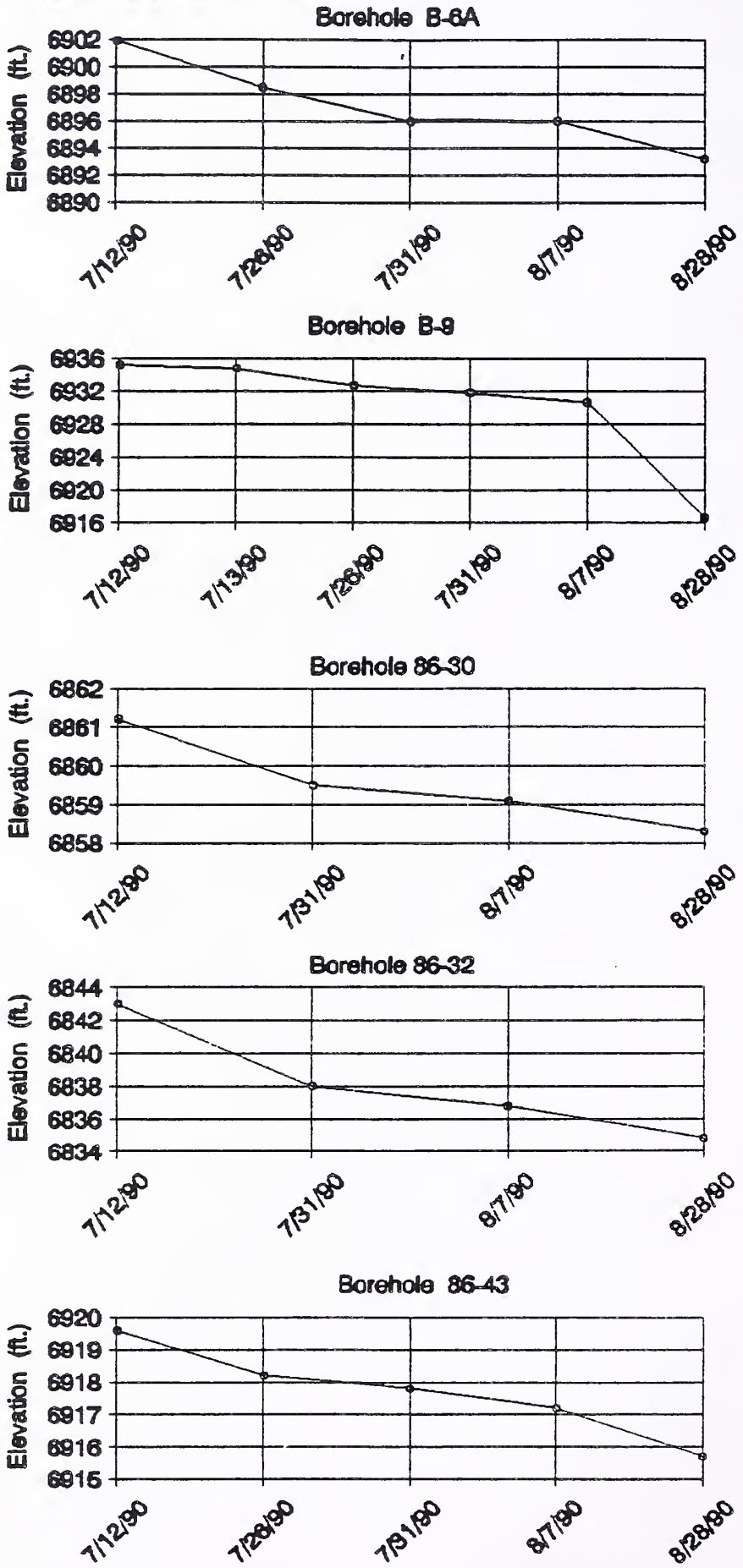


Figure 3.5-7 Borehole Water Level Hydrographs, ABM Ridge

SOURCE: STANSBURY HOLDINGS CORPORATION, 1990b.

within the wetland areas located on either side of the ridge is likely in hydraulic communication with the ABM Ridge bedrock system. Ground water elevations and flow directions previously presented support this contention. If valid, the perennial nature of the wetlands is believed to be primarily supported by the bedrock ground water system, and secondarily sustained by localized perched water within the valley-fill material overlying the bedrock.

The amount and rate of flow of ground water within the ABM Ridge bedrock system is unknown. No data are available on ground water hydraulics necessary to determine the permeability and storage characteristics of the system.

GROUND WATER QUALITY

Ground water quality samples were collected from ABM Ridge boreholes 86-37, 86-18, and 86-14 on August 13, 1990; laboratory analytical results are presented in Table 3.5-5. Borehole 86-37 is located upgradient, adjacent to the wetland on the east side of ABM Ridge while boreholes 86-14 and 86-18 are located downgradient to the south and west side, respectively, of the ridge (see Figure 3.5-5). Prior to sampling, approximately one borehole volume was evacuated from each borehole using a pvc bailer. Borehole purging and sampling is not standard protocol for ground water quality sampling; standard ground water sampling practice is to collect water samples from a screened and properly developed well. Nevertheless, results indicate a strong similarity between the ground and surface water systems. Figure 3.5-8, a trilinear plot of the major cations and anions, indicates a strong calcium-bicarbonate ($Ca\text{-}HCO_3$) ground water. Total dissolved solids concentrations were however notably higher than all the surface water samples (with the exception of WV-13). Boreholes 86-14 and 86-18 had total dissolved solids (TDS) concentrations of 216 and 217 mg/L, respectively, while borehole 86-37 had a TDS concentration more than twice as high at 473 mg/L. The higher TDS at borehole 86-37 was primarily due to increased bicarbonate and calcium concentrations. Fluoride, chloride, nitrate plus nitrate and magnesium concentrations were also notably higher. Of interest, ground water quality at borehole 86-18 was almost identical to the surface water sampled at WV-13 (also called Spring 9). This close similarity supports the previously discussed contention that the ground water system of ABM Ridge is in hydraulic communication with and supports, in part, the wet meadows hydrologic balance.

3.6 AQUATIC LIFE

The aquatic habitats in and around the Western Vermiculite mine site are limited to small perennial streams, intermittent tributaries, and wetlands. St. Clair Creek, which drains the mine site, is a perennial stream characterized by steep gradients with narrow, deep, V-shaped channels at the headwaters, and low-to-moderate gradients in the lower reaches. Wetland areas are located at the mine site.

FISHERIES

The potential for St. Clair Creek to maintain a resident fishery is fairly good. The lower portion of the creek has a high biomass of macroinvertebrates (Mangum, 1988) which can support a larger population of trout than the upper reaches. The upper reaches of St. Clair Creek have less macroinvertebrate diversity and biomass, with no trout being observed (USFS, 1990a; MDFWP, 1978). Sedimentation may be a possible cause for reduced biomass in the upper portions of St. Clair Creek. Starting five miles downstream of the mine site and extending to the confluence with Gird Creek, there is an established fishery consisting of Westslope cutthroat trout (*Oncorhynchus clarki lewisii*); bull trout (*Salevelinus confluentus*), and brook trout (*Salevelinus fontinalis*). The dominant trout species in St. Clair Creek is the Westslope cutthroat trout, and is listed as a State species of concern as well as a Region One Sensitive Species for the Bitterroot National Forest (BNF). The same classification is also assigned to the bull

TABLE 3.5-5

GROUND WATER QUALITY DATA SUMMARY

Parameter	Borehole ID: / Date:	86-18 8/13/90	86-14 8/13/90	86-37 8/13/90
pH (standard units)		7.02	7.8	7
Total Phosphorus (mg/L)		0.0744	0.0893	0.0329
Nitrate/Nitrite Nitrogen (mg/L)		0.026	0.02	0.202
Silica (mg/L)		8.06	5.82	6.99
Major Cations (mg/L)				
Calcium		34.83	38.04	93.47
Magnesium		7.521	7.264	13.26
Sodium		1.734	1.251	2.003
Potassium		9.08	8.81	12.13
Major Anions (mg/L)				
Chloride		1.81	0.95	8.2
Sulfate		< 1.0	10.4	< 1.0
Total Alkalinity (as $CaCO_3$)		133	122	282
Flouride		0.073	0.073	0.052
Total Recoverable Metals (mg/L)				
Aluminum		0.026	0.007	< 0.007
Cadmium		< 0.0008	< 0.0008	< 0.0008
Copper		0.0001	0.0026	< 0.005
Iron		0.067	0.017	< 0.002
Manganese		0.175	0.0924	0.0104
Mercury		0.003	0.004	0.021
Zinc		0.0018	0.0014	0.002

Source: Stansbury Holdings Corporation, 1990b.

Note: Metals are dissolved.

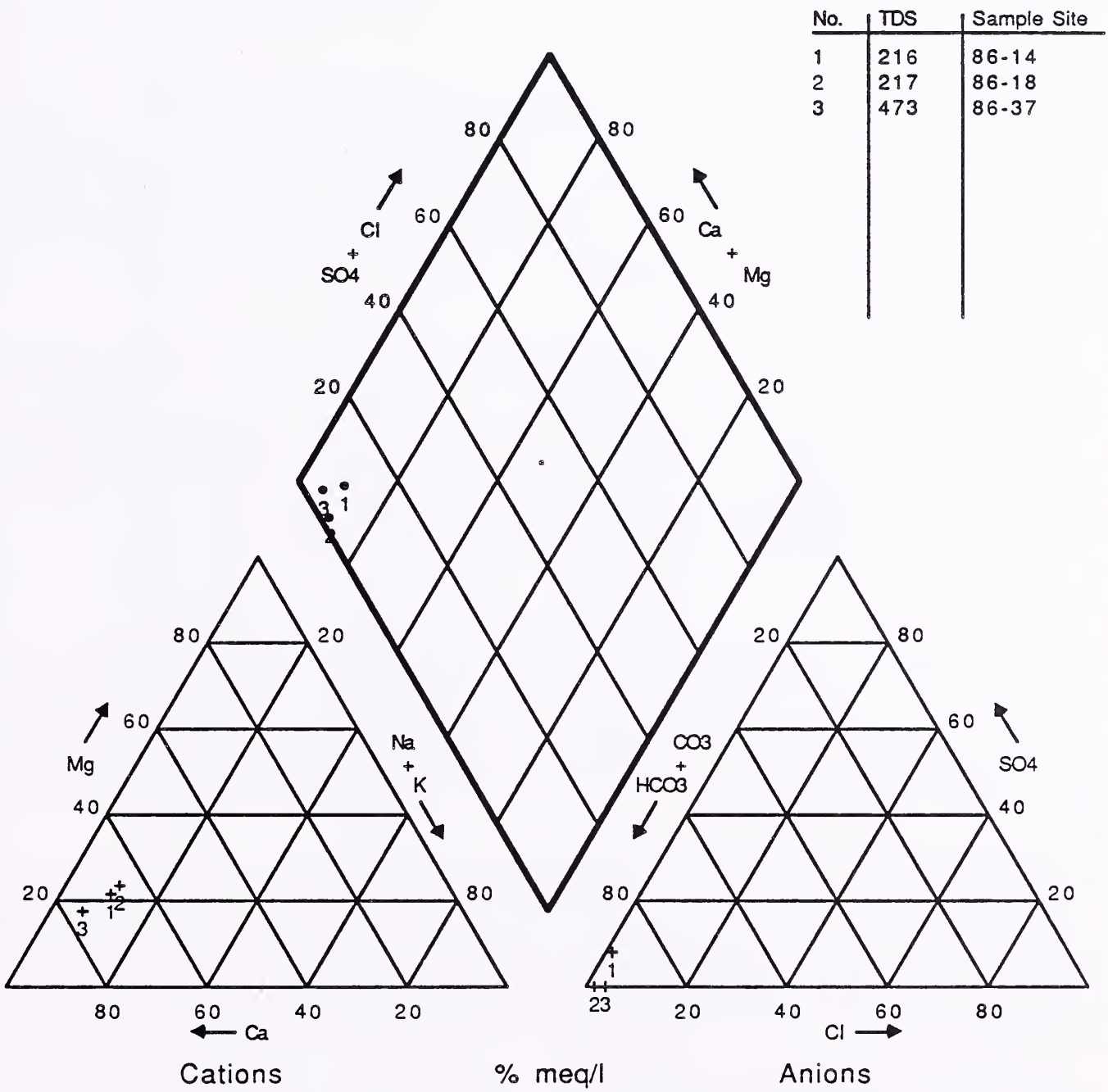


Figure 3.5-8 Trilinear Plot of Ground Water Quality Data

SOURCE: STANSBURY HOLDINGS CORPORATION, 1990b.

trout. Considerable effort is being put forth by the Montana Department of Fish, Wildlife, and Parks to increase the distribution of these species in Montana.

A recreational fishery is well established in the Bitterroot Valley, with a majority of the fishing pressure occurring on the Bitterroot River. Steep terrain and private land prevents fishermen from gaining access to upper St. Clair Creek, which limits the number of anglers in this area.

MACROINVERTEBRATES

Macroinvertebrates are very important in the general ecology of aquatic environments. They convert small food particles into sizes that can more conveniently be utilized by fish and other larger organisms. A majority of the aquatic macroinvertebrates are immature stages of various insect orders, but they also include crustaceans, flatworms, roundworms, molluscs, and adult insects. Macroinvertebrates, collectively, are excellent indicators of water quality, as expressed in indices of community structure. Additionally, these organisms are indicative of water quality by their individual sensitivity to pollutants and other stresses (intolerant vs. tolerant).

The Aquatic Ecosystem Analysis Laboratory-USFS conducted aquatic sampling of the macroinvertebrate communities residing in the benthic substrate of St. Clair Creek (Magnum, 1983, 1987, and 1988). Their sampling results indicate that the water quality in St. Clair Creek is fairly good, as reflected by the diverse assemblage of macroinvertebrate fauna. Their reports show that the macroinvertebrate community is stressed in certain portions of the St. Clair Creek, as demonstrated by the presence of tolerant species, and absence of sensitive mayfly species. The source of environmental stress is unknown. Table 3.6-1 shows the diversity and abundance of macroinvertebrates in St. Clair Creek.

3.7 WILDLIFE

The wildlife resources that occur within the Western Vermiculite mine site are those commonly associated with the coniferous forests of the northern Rocky Mountains. The mine site is located on the ABM Ridge in the BNF, which is characterized by steep slopes, vegetated primarily by lodgepole pine/subalpine fir, beargrass, shrubs, and interspersed with grassy balds and dry mountain meadows. The forest surrounding the mine site is young, as evidenced by small diameter trees. Older growth forests exist near the permit boundary and isolated areas along the haul road.

The mixed conifer type is an important area for security and thermal cover for large game mammals that occur in and near the mine site. Understory in this forest type provides ample forage for big game and numerous small animals. Clear-cut habitat is present in limited acreage within the study area, which is comprised of grasses and shrubs that represent an important forage base for big game mammals, as well as various small animals. The limited grasslands within the permit area provide forage for large game mammals and forage and cover for small mammals.

WILDLIFE - ELK AND MULE DEER

The area surrounding the mine site is important for its diversity of big game and is a valuable recreation area for sport hunting. Managing the wildlife resources has been, and continues to be, a major objective of the Montana Department of Fish, Wildlife, and Parks and the U.S. Fish and Wildlife Service (USFWS). The USFS is responsible for managing wildlife habitat. Populations of elk (*Cervus elaphus*) and mule deer (*Odocoileus hemionus*) are both hunted in the project area. The Skalkaho Game Preserve, located 0.5 mile east of the mine site, is valuable summer range for elk and mule deer, with no hunting allowed in this area. Approximately 700 elk utilize the Preserve during the summer/early fall period.

TABLE 3.6-1

MACROINVERTEBRATES FOUND IN ST. CLAIR CREEK AND THEIR RESPECTIVE ABUNDANCE

Class	Order	Family	Genus	Species	Abundance[1]
Arachnida	Hydrocarina				C
Crustacea	Copepoda				F
Crustacea	Ostracoda				D
Insecta	Coleoptera	Elmidae			D
Insecta	Diptera	Ceratopogenidae			F
Insecta	Diptera	Chironomidae			A
Insecta	Diptera	Empididae			D
Insecta	Diptera	Pelecorhynchidae	Glutops	Rossi	E
Insecta	Diptera	Psychodidae	Pericoma		D
Insecta	Diptera	Simuliidae			D
Insecta	Diptera	Tipulidae	Hexatoma		F
Insecta	Diptera	Tipulidae	Antocha	Monticola	F
Insecta	Diptera	Tipulidae	Dicranto		F
Insecta	Ephemeroptera	Baetidae	Baetis		A
Insecta	Ephemeroptera	Ephemerellidae	Ephemevella	Coloradensis	F
Insecta	Ephemeroptera	Ephemerellidae	Ephemevella	Doddsi	F
Insecta	Ephemeroptera	Ephemerellidae	Ephemevella	Edmundsi	D
Insecta	Ephemeroptera	Ephemerellidae	Ephemevella	Grandis	F
Insecta	Ephemeroptera	Ephemerellidae	Ephemevella	Hystrix	E
Insecta	Ephemeroptera	Ephemerellidae	Ephemevella	Inermis	C
Insecta	Ephemeroptera	Heptageniidae	Heptagenia		
Insecta	Ephemeroptera	Heptageniidae	Cinygmula		D
Insecta	Ephemeroptera	Heptageniidae	Epeorus		D
Insecta	Ephemeroptera	Heptageniidae	Rithrogena		F
Insecta	Ephemeroptera	Leptophlebiidae	Paraleptophlebia		E
Insecta	Ephemeroptera	Siphlonuridae	Ameletus		F
Insecta	Plecoptera	Capniidae			F
Insecta	Plecoptera	Chloroperlidae			D
Insecta	Plecoptera	Leuctridea			D
Insecta	Plecoptera	Nemouridae	Zapada		D
Insecta	Plecoptera	Perlidae			F
Insecta	Plecoptera	Perlodidae	Isoperla		E
Insecta	Plecoptera	Perlodidae	Megarcys		F
Insecta	Plecoptera	Taeniopterygidae	Taenionema		F
Insecta	Trichoptera	Brachycentridae	Micrasema		D
Insecta	Trichoptera	Glossosomatidae	Glossosoma		D
Insecta	Trichoptera	Hydropsychidae	Arotopsyche	Grandis	E
Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche		F
Insecta	Trichoptera	Hydropsychidae	Parapsyche		F
Insecta	Trichoptera	Lepidostomatidae			F
Insecta	Trichoptera	Limnephilidae	Chryanda		F
Insecta	Trichoptera	Limnephilidae	Ecclisomyia		F

TABLE 3.6-1 (cont.)

MACROINVERTEBRATES FOUND IN ST. CLAIR CREEK
AND THEIR RESPECTIVE ABUNDANCE

Class	Order	Family	Genus	Species	Abundance[1]
Insecta	Trichoptera	Limnephilidae	Neothremma		D
Insecta	Trichoptera	Limnephilidae	Cryptochia		F
Insecta	Trichoptera	Rhyacophilidae	Rhyacophila		D
Oligochaeta					A
Turbellaria	Tricladida	Planariidae	Planaria		D

Source: Mangum, 1983, 1987, and 1988.

[1] Abundance is based upon the mean number of organisms per square meter.
A = >1000
B = 750-999
C = 500-749
D = 100-499
E = 50-99
F = <50

The MDFWP has reported rutting activity on the Preserve and near the mine site during late summer and early fall. The permit area contains excellent summer/fall habitat for elk and mule deer.

Located approximately 4 miles west of the mine site is the Bitterroot Game Range and the Bitterroot Stock Farm (Figure 3.7-1). These two areas represent winter range for elk and also are areas for calving during early spring. The Bitterroot Stock Farm, which is privately owned and managed, has recently been offered for sale.

St. Clair Creek and the associated drainage area provide access for elk to and from the Bitterroot Stock Farm during winter and spring migrations. The St. Clair Creek drainage also provides important security for elk during hunting season (MDSL/USFS, 1979). The mine site is situated between the summer range and winter range, and is within the major migration corridor for elk. Calving occurs on the winter range and in the migration corridor as the elk move to summer range (personal communication, John Ormiston, 1990).

Mule deer populations within the mine site and the surrounding areas are much lower than elk populations. Projected mule deer population in the general area is approximately 300 animals (personal communication, Lynn Nielsen, 1990). Mule deer have been observed along the proposed haul road and at the mine site but their density is low. The seasonal range use is similar to elk, but they are more widely scattered over the summer range. Very few mule deer are found on elk winter range; instead, the deer primarily winter in the Skalkaho-Gird Ridge area.

WILDLIFE - UPLAND GAME BIRDS

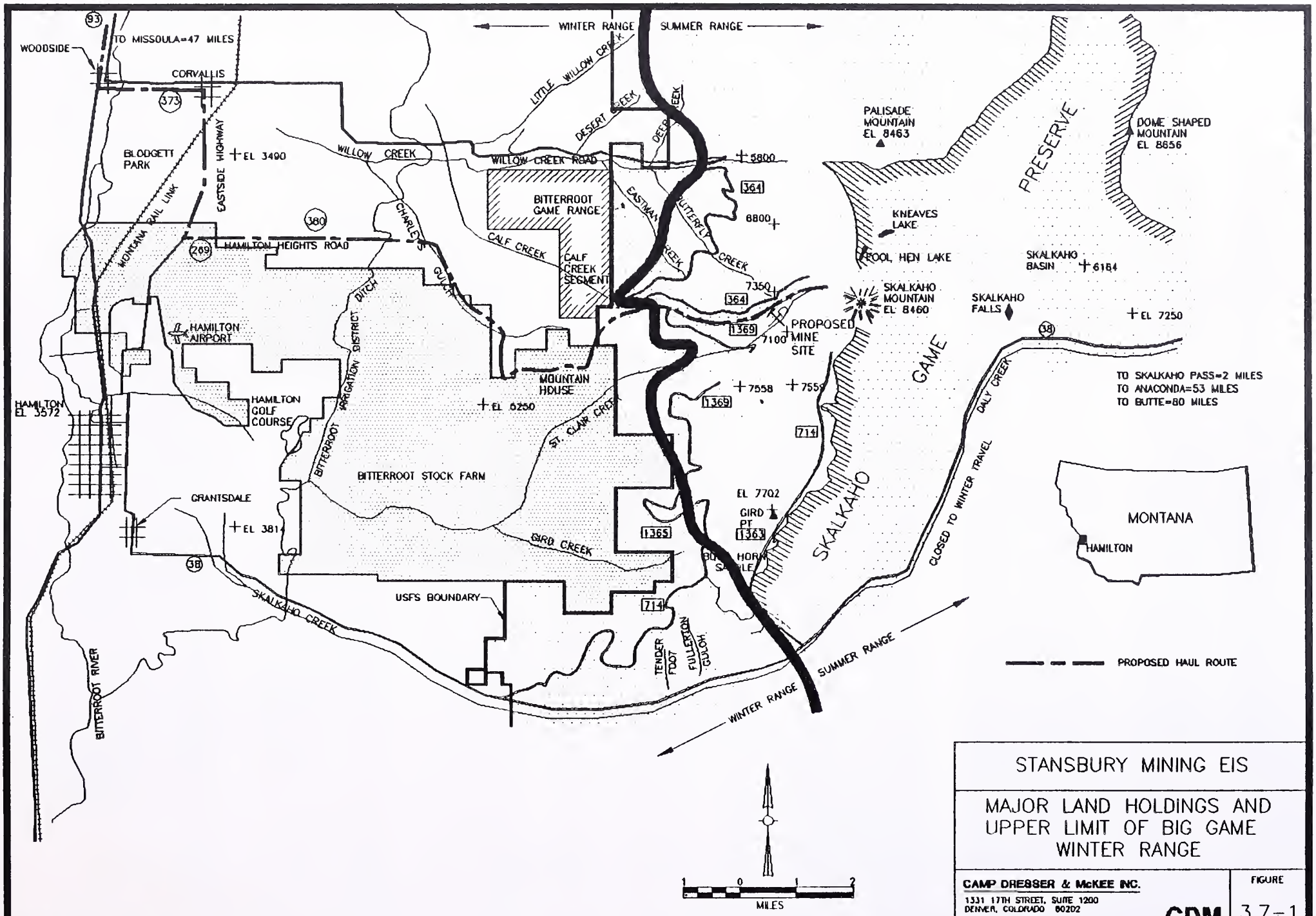
Blue grouse (*Dendragapus obscurus*) and the Spruce grouse (*Dendragapus canadensis*) are the most common upland game birds found in the project area. Both of these species are commonly observed along the haul road near the mine site. The mixed-conifer type found in the project area is excellent winter habitat for these species.

WILDLIFE - SMALL MAMMALS AND SPECIES OF CONCERN

Small mammals found in the vicinity of the mine site and haul road are the snowshoe hare (*Lepus americanus*), red squirrel (*Tamiasciurus hudsonicus*), and numerous other species of small mammals. The fisher (*Martes pennanti*) was reintroduced in the 1950s into the Sapphire Mountains and a small population continues to exist there today. No fishers have been observed in the permit area.

The pine marten (*Martes americana*) is a management indicator species for the BNF. The marten is dependent upon old growth/mature forests, with ideal habitat consisting of more than 40 percent subalpine fir and spruce. The forest immediately surrounding the mine site is young in age and most likely does not contain suitable marten habitat. Mature forests are found along portions of the haul road and evidence of marten trapping is prevalent in this area. Pine marten tracks have also been observed in the project area during winter marten surveys.

The boreal owl (*Aegolius funereus*) is listed as a sensitive species for the BNF. Boreal owls inhabit dense stands of old growth forests at high elevations in the northern Rockies. The owls are dependent upon old growth forests during the breeding season, using cavities in mature trees for nesting and rearing young. Forest types associated with appropriate habitat are Engelmann spruce, subalpine fir, and lodgepole pine, all of which are found on the mine site. However, the young age structure of this forest type is not appropriate habitat for these owls. The occurrence of these owls in the vicinity of the mine site is very rare. A breeding pair of boreal owls was observed in Lolo National Forest, Missoula County,



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MAJOR LAND HOLDINGS AND UPPER LIMIT OF BIG GAME WINTER RANGE

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FIGURE 3.7-1

in 1984. The closest known boreal owl observation to the mine site was a calling male heard in the Sapphire Divide (Ambrose Saddle area), about 30 miles away. This owl was heard during a 1989 owl survey (Ormiston, 1990).

The western big-eared bat (*Plecotus townsendii*), also listed as a sensitive species, is found in a wide variety of habitats and has a close association with rocky outcrops where caves, crevices or abandoned mine tunnels are available. Observations of the western big-eared bat have been recorded in the Bitterroot valley, but no observations have been made at the mine site. Habitat components for this species are not present at the mine site, or in the immediate area.

THREATENED AND ENDANGERED SPECIES

Two Federal and State protected endangered species have been reported in the general project area: the peregrine falcon (*Falco peregrinus anatum*) and the northern bald eagle (*Haliaeetus leucocephalus alascanus*). Peregrine falcons have been observed during migration in the Sapphire Mountains, with no recent signs of nesting. The Western Vermiculite mine site and adjacent area does not contain suitable nesting habitat for the falcon. The northern bald eagle occurs in the Bitterroot Valley during the winter, and during the fall and spring migration periods. Habitat preference for the bald eagle during these periods are trees found along large river systems and lakes. The trees are used primarily for roosting, with little nesting occurring in the BNF. The Western Vermiculite mine site does not have the appropriate habitat components for these threatened and endangered species (USFWS, 1990).

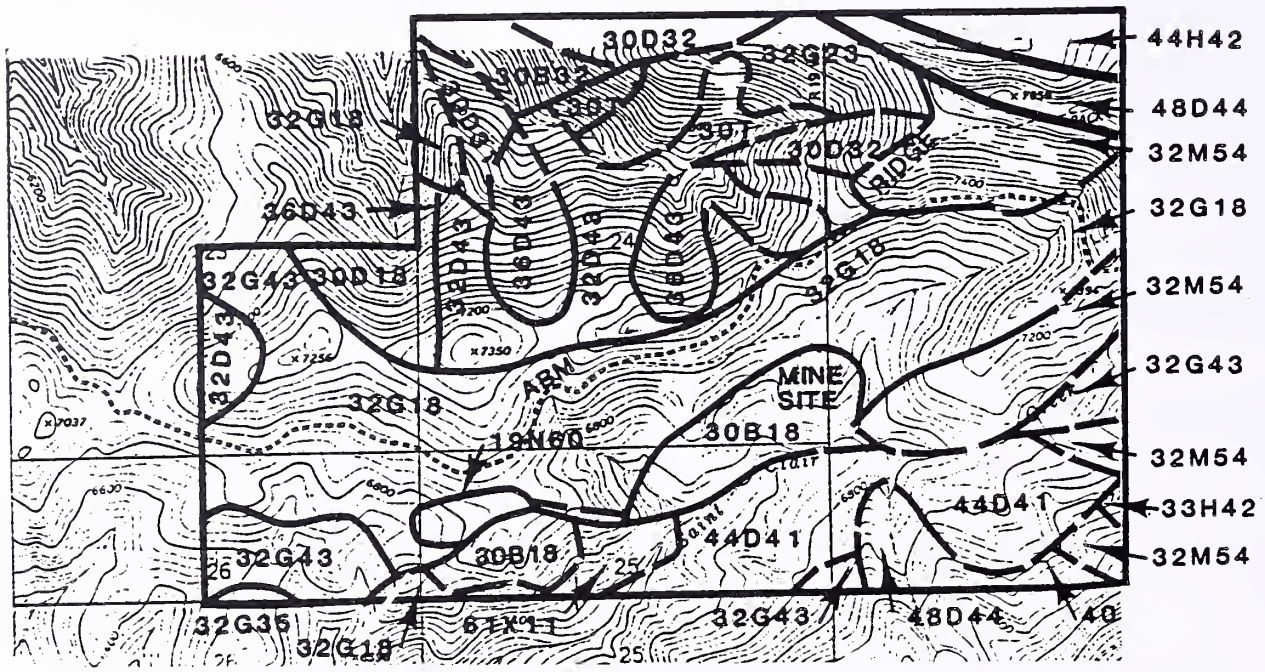
3.8 SOILS

GENERAL CHARACTERISTICS

Much of the ABM Ridge has been disturbed during previous mining. Original soils have been lost, or placed in a stockpile that is present on the site. Natural soils on the ABM Ridge and the proposed HRWS site have developed on mostly convex slopes, and are shallow where bedrock is close to the surface or exposed as rock outcrops. In the few concave sites present, soils are deep where colluvium and minor amounts of alluvium have washed in from adjacent convex sites. Surface soil textures on convex sites are generally loamy sands to sandy loams, while subsoils are loamy sands to sands. Coarse fragment contents range from 40 to 60 percent gravel and/or cobbles by volume throughout the soil profile. Slopes are nearly level to gently undulating on broad ridge tops and moderately steep to very steep along valley walls. Parent materials are ultramafic amphibolite intrusive rocks on ABM Ridge and syenite on the HRWS site. Soils are generally low in nutrients, and exhibit low to moderately low water holding capacities and moderately rapid to rapid permeability. Soils in swales have slightly higher nutrient values, hold more water and have slower permeability. Soils of the swales immediately east and west of the existing mined area are hydric (show the effects of persistent saturation) and some are histosols (organic soils).

TAXONOMIC AND MANAGEMENT CHARACTERISTICS

Soils of the ABM Ridge site that are to be affected are of two suborders within the soil order Inceptisols. Soils of the lower portion of the ABM Ridge site are *Typic Ustochrepts* (Figure 3.8-1). These soils are usually four or more feet deep above bedrock, have no volcanic ash on the surface, have moderate disturbed surface erosion hazard, have little danger of mass failure, and have low compaction hazard (McBride, 1990). Slopes vary mostly from about 25 to 35 percent within the study area.



LEGEND

Map Unit	Description
19N60	Aquents - Fluvents complex, alluvial basin
30B18	Typic Ustochrepts, steep mountain slopes
30B32	Typic Ustochrepts - Typic Eutroboralfs complex, steep mountain slopes, metasedimentary substratum
30D18	Dystric Cryochrepts, steep mountain slopes, moist
30D31	Dystric Cryochrepts - Typic Cryoboralfs complex, steep mountain slopes
30D32	Dystric Cryochrepts - Typic Cryroboralfs complex, steep mountain slopes, metasedimentary substratum
30T	Rubble land, steep mountain slopes
32D43	Dystric Cryochrepts, moderately steep mountain slopes, moist
32G18, 32G23, 32G43	Dystric Cryochrepts, moderately steep mountain slopes
32G35	Dystric Cryochrepts - Typic Cryoboralfs complex, moderately steep mountain slopes
32M54	Borolls, mountain uplands, and ridges
33H42	Andic Cryochrepts, mountain uplands and ridges
36D43	Andic Cryochrepts, stream headlands
40	Rock Outcrop - Cryochrepts complex, cirque headwalls, alpine ridges and trough walls
44D41	Dystric Cryochrepts, moraines, moist
44H42	Dystric Cryochrepts, moraines, quartzitic substratum
48D44	Dystric Cryochrepts, undissected trough walls - moist
61X11	Ochrepts - Rock outcrop complex, breaklands

SOURCE: McBRIDE, 1990.

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SOILS/LANDTYPE DISTRIBUTION

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SHEET NO 3.8-1

Soils of the upper portion of the ABM Ridge site, the haul road, and the HRWS site are *Dystric Cryochrepts*. These soils typically have three or more feet of material above bedrock, are derived from granitic parent materials, have surface horizons with at least some influence from volcanic ash, have moderate disturbed surface erosion hazard, little danger of mass failure, and moderate to high compaction hazard (McBride, 1990). Slopes vary from about 15 to 40 percent within the study area.

PHYSICAL AND CHEMICAL CHARACTERISTICS

Soils of the project area are shown in Figure 3.8-1. Samples from the entire depth of the soil to parent material were analyzed. Parameters and results are shown in Table 3.8-1.

Soils are generally very coarse with coarse fragments mostly 20 to 30 percent and the fine earth fraction having mostly loamy sand texture. Soil reaction is moderate to slightly acid with pH ranging from 5.0 to 6.7. Nutrients are available in modest amounts as is typical of such coarse-textured material. Physically, these soils are within DSL recommended standards for reclaimable soils.

Chemical analyses show the manganese (Mn) content in sample site 5 at 103 ppm. DSL lists the threshold limits for Mn at 70 ppm. According to the National Research Council (1973), the mobility of Mn is determined by the availability of soluble and easily reducible Mn in the parent material, concentrations of other cations, cation exchange capacity, and pH. The Sample 5 soils mineralogy obviously contains high concentrations of Mn. This, in combination with a low pH (5.0), provides an environment for elevated amounts of mobile Mn. A study in Scotland of more than 100 soil profiles showed a range of naturally available Mn to be from less than 0.8 to 130 ppm (Swaine and Mitchell, 1960). This study indicates that although the 1Ab soil is high in Mn, it is not out of the normal range.

The logged area from the vicinity of soil Sample 5 was vegetated with a canopy of mature conifers and an understory of shrubs and grasses. No indications of toxicity in the new growth or in the existing forest cover were evident around the perimeter of the clear cut.

3.9 VEGETATION

Vegetation resources of the access road and mine vicinities were described in the 1979 draft EIS/EA for the Western Vermiculite operation (DSL/USFS, 1979) and in the EA for the St. Clair Creek Timber Sale (USFS, 1980). The following discussion reviews this information, with the addition of updated material pertinent to rare plant species and to vegetation resources specific to the most recently proposed alternative treatments. Field reconnaissances of the access road and mine site were conducted in May 1987 and August 1990.

VEGETATION TYPES

Forested types and estimated yield capabilities are summarized in Table 3.9-1 for the site based on Pfister et al. (1977). Agricultural, grassland and shrubland types are named according to existing species dominance, or follow habitat types described by Mueggler and Stewart (1980).

Access Road

General wildlife habitat types mapped by the Montana Department of Natural Resources and Conservation (1976) for the region encompassing the access road and mine site were included in the draft EIS/EA (DSL and USFS, 1979). From State Highway 269, the access road travels through approximately four miles of agricultural land (irrigated cropland and dry cropland) and bottomland. Cropland is primarily alfalfa

TABLE 3.8-1

RESULTS OF CHEMICAL AND PHYSICAL SOIL ANALYSES
WESTERN VERMICULITE PROJECT

	Soil Sample Location					
	1 (30b18)[a]	2 (30b18)[a]	3 (32g18)[a]	4[b]	5 (32D43)[a]	6[c]
Land Depth, inches	0-12	0-10	0-24	N/A	0-4	N/A
pH	6.6	5.9	5.5	6.7	5.0	7.7
Saturation, %	30.7	25.2	21.0	22.3	40.3	23.3
Conductance, mmhos/cm	0.38	0.23	0.17	0.27	0.44	0.35
Sand, %	80	80	84	82	72	82
Silt, %	19	17	13	15	25	15
Clay, %	1	3	3	3	3	3
VFS, %	4	8	10	8	13	13
Texture[1]	LS	LS	LS	LS	SL	LS
Organic Carbon, %	3.05	3.02	2.50	2.18	7.42	2.22
Nitrate-N, ppm	1.6	< 1	< 1	< 1	8.9	< 1
Avail. Potassium, ppm	69	81	82	76	223	109
Avail. Phosphorous, ppm	23	57	51	30	29	7
Arsenic, ppm	0.04	0.05	0.04	0.03	0.03	0.03
Cadmium, ppm		< 0.1	< 0.1		< 0.1	
Copper, ppm		0.4	0.5		0.9	
Manganese, ppm		11.8	8.3		103	
Zinc, ppm	0.7	0.3	0.3	0.4	2.4	
Coarse Fragments, %	27.8	29.6	19.1	13.5	32.1	2.0

Source: Stansbury Holdings, 1990a.
[1]USDA Textural Class Key:
LS = Loamy Sand
SL = Sandy Loam
[a] Soil type
[b] Existing topsoil stockpile
[c] Host rock sample

or pasture heavily infested with spotted knapweed. Non-agricultural bottomland (primarily Charleys Gulch) is mostly occupied by deciduous thicket, dominated by various mixtures of quaking aspen, water birch, willows, chokecherry, red osier dogwood and mountain maple. The access road then crosses approximately three miles of grassland, shrubland, and low elevation forest. Lower elevation grassland on warm aspects with relatively shallow soils is primarily the bluebunch wheatgrass/native bluegrass habitat type, highly degraded by invasion of spotted knapweed. The Idaho fescue/bluebunch wheatgrass habitat type is found on cooler sites with deeper soils at slightly higher elevations. Where big sagebrush is a dominant element, the big sagebrush/bluebunch wheatgrass habitat type generally corresponds with site parameters of the first grassland type, and the big sagebrush/Idaho fescue habitat type with the second. These latter types are also infested with knapweed in most locations.

The access road enters forest in the Douglas-fir/ponderosa pine zone, primarily in the Douglas-fir/mallow ninebark and Douglas-fir/pinegrass habitat types. Upper limits of the access road are in the subalpine fir zone: on warmer exposures primarily the subalpine fir/beargrass habitat type, and on cooler exposures the subalpine fir/menziesia habitat type.

ABM Ridge Mine Site, Haul Road, and Alternative Host Rock Waste Stockpiles

Habitat types (kinds of potential vegetation) in areas proposed for mine-associated disturbance are identified in Table 3.9-1. Of four subalpine fir habitat types in the area, subalpine fir/beargrass is the most prevalent, particularly the blue huckleberry phase. Subalpine fir is the potential dominant tree of these sites, but succession has not proceeded to that point as yet. The bulk of the forest cover on the site is comprised of lodgepole pine with lesser amounts of Douglas-fir, and only a small representation of subalpine fir. On the mine site, approximately 20 acres have been previously disturbed and are either totally bare or sparsely vegetated. No old-growth forest is present in the project area.

The subalpine fir/beargrass habitat type is found at all but the highest elevations in the mine area on broad, warmer slopes. Subalpine fir/menziesia is also prevalent on cooler (north and east) exposures. Subalpine fir/bluejoint is restricted to bottoms and concavities with high soil moisture, usually near perennial streams. The subalpine fir/smooth woodrush habitat type is present on the upper limit of the proposed HRWS site.

Park-like openings in forest stands are dominated by beargrass and herbaceous species such as elk sedge, pinegrass, and various forbs. These openings are most extensive on southerly exposed ridges with relatively shallow soil development, such as ABM Ridge. Seeps are limited to very localized portions of drainage bottoms where ground water appears at the surface regularly during the growing season. Water table and perhaps substrate parameters preclude establishment of conifers on these sites, and the herbaceous vegetation present includes many taxa common to the subalpine fir/bluejoint understory. Dominant taxa also include horsetail, sedge, rush, moss and various forbs. Wetlands extend upslope in two wide swales toward the ABM Ridge site from the southwest and southeast.

SPECIES LIST/RARE PLANTS

A list of plant species identified in the ABM Ridge area is included in Table 3.9-2. Identification of plant taxa occurred during May 1987 and August 1990. No sensitive or watch plants for Bitterroot National Forest were found at the mine or HRWS site (Shelly, 1990).

One rare plant species occurs adjacent to the access road, near the mouth of Charleys Gulch. *Arabis fecunda* Rollins (Sapphire rockcress) has the most restricted range of rare plant species in Montana and is the best example in the state of a restricted endemic (Shelly, 1990). Limited to a small area in the

TABLE 3.9-1

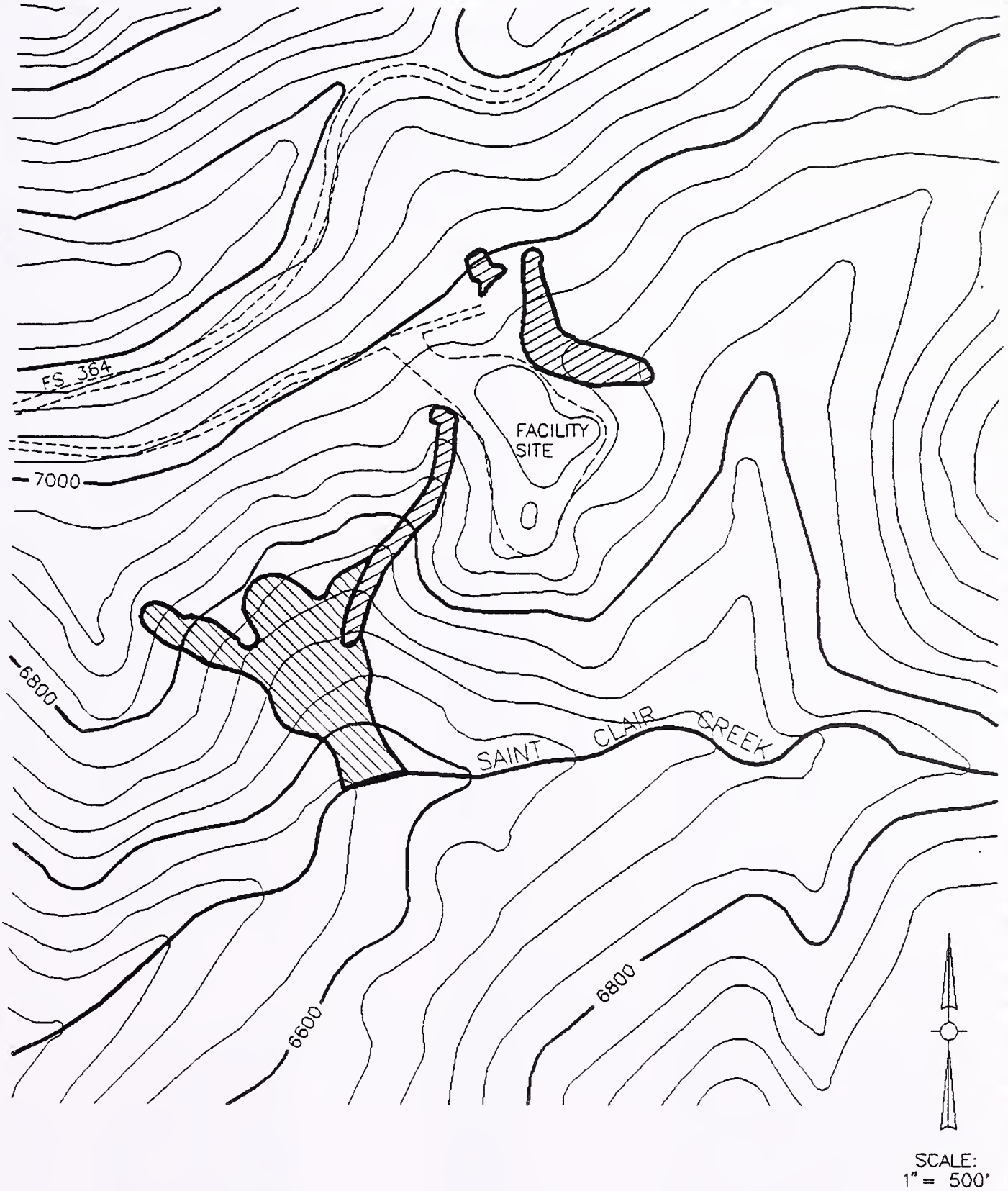
HABITAT/COMMUNITY TYPES AND YIELD CAPABILITIES
PRESENT IN THE ABM RIDGE AREA
BY TYPE OF DISTURBANCE
RAVALLI COUNTY, MONTANA

Type (Potential Overstory/ Understory Dominants)	ABM Ridge Mine	Haul Road	HRWS Site A	Mean Yield Capability (Cubic feet/acre/year)
Subalpine fir/menziesia (ALBA/MEFE)	2		2*	80
Subalpine fir/bluejoint (ALBA/CACA-CACA)	2			62
Subalpine fir/beargrass (ALBA/XETE-VASC) (ABLA/XETE-VAGL)	1	1	1 2**	62
Subalpine fir/woodrush (ABLA/LUH1)				31
Parks (e.g. Xete/Cage, (Caru/Cage)	1		2	
Seeps (see text)	2			

Source: Stansbury Holdings, 1990a.

NOTES:

1 = Major component
2 = Minor component
* May be present, depending on final engineering of stockpile.
** Clearcut



SCALE:
1" = 500'

LEGEND

WETLANDS CLOSELY ASSOCIATED WITH ABM RIDGE & POSSIBLY HYDROLOGICALLY TIED TO ABM

WETLANDS OF SLOPES ADJACENT TO ABM RIDGE & NOT LIKELY HYDROLOGICALLY TIED TO ABM

SOURCE: STANSBURY HOLDINGS, 1990 a.

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WETLANDS ASSOCIATED WITH ABM RIDGE

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FIGURE 3.9-1

TABLE 3.9-2

VEGETATION SPECIES LIST
ABM RIDGE AREA (6,400-7,350 FEET ELEVATION)
RAVALLI COUNTY, MONTANA
MAY 1987 AND AUGUST 1990

Scientific Name	Code	Common Name
GRASSES AND GRASS-LIKE PLANTS (sedges, rushes, etc.)		
Agropyron caninum	Agr can	Bearded Wheatgrass
Agropyron intermedium	Agr int	Intermediate Wheatgrass
Agrostis sp.	Agr sp.	Bentgrass
Bromus carinatus	Bro car	Mountain Brome
Calamagrostis rubescens	Cal rub	Pinegrass
Carex aquatilus	Car aqu	Water Sedge
Carex concinnoides	Car con	Northwest Sedge
Carex geyeri	Car gey	Elk Sedge
Carex microptera	Car mic	Smallwing Sedge
Carex rossii	Car ross	Ross Sedge
Dactylis glomerata	Dac glo	Orchardgrass
Elymus sp.	Ely sp.	Wildrye
Festuca idahoensis	Fes ida	Idaho Fescue
Glyceria sp.	Gly sp.	Mannagrass
Juncus ensifolius	Jun ens	Dagger-leaf Rush
Luzula sp.	Luz sp.	Woodrush
Phleum pratense	Phl pra	Common Timothy
Poa nervosa	Poa ner	Wheeler's Bluegrass
Stipa occidentalis	Sti occ	Western Needlegrass
Trisetum spicatum	Tri spi	Spike Trisetum
FORBS		
Achillea millefolium	Ach mil	Common Yarrow
Actaea rubra	Act rub	Red Baneberry
Agoseris spp.	Ago ssp.	False Dandelion
Anaphilus margaritacea	Ana mar	Pearly-everlasting
Antennaria microphylla	Ant mic	Rose Pussytoes
Arabis holboellii	Ara hol	Holboel Rockcress
Arenaria cf. capillaris	Are cap	Mountain Sandwort
Arnica cordifolia	Arn cor	Heartleaf Arnica
Arnica mollis	Arn mol	Hairy Arnica
Aster conspicuus	Ast con	Showy Aster
Aster spp.	Ast spp.	Aster
Balsamorhiza sagittata	Bal sag	Arrowleaf Balsamroot
Calypso bulbosa	Cal bul	Fairy-slipper
Carduus nutans	Car nut	Musk Thistle
Castilleja hispida	Cas his	Harsh Paintbrush

TABLE 3.9-2 (Cont'd)

VEGETATION SPECIES LIST
ABM RIDGE PROJECT AREA (6,400-7,350 FEET ELEVATION)
RAVALLI COUNTY, MONTANA
MAY 1987 AND AUGUST 1990

Scientific Name	Code	Common Name
Castilleja miniata	Cas min	Scarlet Paintbrush
Cirsium arvense	Cir arv	Canada thistle
Cirsium vulgare	Cir vul	Bull Thistle
Claytonia lanceolata	Cla lan	Western Springbeauty
Collinsia parviflora	Col par	Blue-eyed Mary
Cryptantha affinis	Cry aff	Common Hiddenflower
Descurainia sp.	Des sp.	Tansymustard
Delphinium bicolor	Del bic	Litle Larkspur
Epilobium angustifolium	Epi ang	Fireweed
Epilobium ciliatum	Epi cil	Ciliate Willowherb
Epilobium paniculatum	Epi pan	Autumn Willowherb
Equisetum arvense	Equ arv	Common Horsetail
Erigeron cf. speciosus	Eri spe	Oregon Fleabane
Erigeron sp.	Eri sp.	Fleabane
Erythronium grandiflorum	Ery gra	Glacier-lily
Fragaria virginiana	Fra vir	Virginiana Strawberry
Gayophytum diffusum	Gay dif	Bigflower Groundsmoke
Geum macrophyllum	Geu mac	Largeleaf Avens
Habenaria dilatata	Hab dil	White Bogorchid
Habenaria saccata	Hab sac	Modoc Bogorchid
Hackelia floribunda	Hac flo	Many-flowered Stickseed
Hedysarum sulphurescens	Hed sul	Sulphur Sweetvetch
Hieracium albiflorum	Hie alb	Whiteflower Hawkweed
Hieracium cynoglossoides	Hie cyn	Houndstongue Hawkweed
Hydrophyllum capitatum	Hyd cap	Waterleaf
Linanthus nuttallii	Lin nut	Nuttall Linanthus
Lomatium triternatum	Lom tri	Nineleaf Lomatium
Lupinus argenteus	Lup arg	Silvery Lupine
Matricaria matricarioides	Mat mat	Pineapple Weed
Melilotus officinalis	Mel off	Yellow Sweetclover
Mimulus gutatus	Min gut	Spotted Monkeyflower
Mimulus lewisii	Mim lew	Lewis Monkeyflower
Mimulus moschatus	Mim mus	Muskplant Monkeyflower
Parnassia fimbriata	Par fim	Rocky Mountain Parnassia
Pedicularis contorta	Ped con	Coiled Lousewort
Penstemon albertinus	Pen alb	Alberta Penstemon
Penstemon procerus	Pen pro	Littleflower Penstemon
Phacelia hastata	Pha has	Silverleaf Phacelia
Potentilla glandulosa	Pot gla	Glandular Cinquefoil
Potentilla gracilis	Pot gra	Northwest Cinquefoil

TABLE 3.9-2 (Cont'd)

VEGETATION SPECIES LIST
ABM RIDGE PROJECT AREA (6,400-7,350 FEET ELEVATION)
RAVALLI COUNTY, MONTANA
MAY 1987 AND AUGUST 1990

Scientific Name	Code	Common Name
Prunella vulgaris	Pru vul	Common Selfheal
Pyrola secunda	Pyr sec	Sideballs Pyrola
Ranunculus uncinatus	Ran unc	Uncinate Buttercup
Saxifraga arguta	Sax arg	Brook Saxifrage
Sedum sp.	Sed sp.	Stonecrop
Senecio triangularis	Sen tri	Arrowleaf Groundsel
Silene menziesii	Sil men	Menzies Campion
Spegularia rubra	Spe rub	Red Sandspurry
Tanacetum vulgare	Tan vul	Common Tansy
Taraxacum officinale	Tar off	Common Dandelion
Thalictrum occidentale	Tha occ	Western Meadowrue
Tiarella trifoliata	Tia tri	Coolwort Foamflower
Trifolium hybridum	Tri hyb	Alsike Clover
Trillium ovatum	Tri ova	White Trillium
Trollius laxus	Tro lax	American Globeflower
Valeriana dioica	Val dio	Northern Valerian
Valeriana sitchensis	Val sit	Sitka Valerian
Veratrum viride	Ver vir	Green Falsehellebore
Verbascum thapsus	Ver tha	Mullein
Veronica americana	Ver ame	American Speedwell
Veronica cf. serpyllifolia	Ver ser	Thyme-leaved Speedwell
Viola adunca	Vio adu	Early Blue Violet
Viola orbiculata	Vio orb	Roundleaf Violet
Xerophyllum tenax	Xer ten	Beargrass
SUBSHRUBS		
Berberis repens	Ber rep	Creeping Oregongrape
Chimaphila umbellata	Chi umb	Common Pipsissewa
Eriogonum umbellatum	Ero umb	Sulphur Buckwheat
SHRUBS		
Acer glabrum	Ace gla	Rocky Mountain Maple
Juniperus communis	Jun com	Common Juniper
Ledum glandulosum	Led gla	Glandular Labrador Tea
Lonicera utahensis	Lon uta	Utah Honeysuckle
Menziesia ferruginea	Men fer	Rusty Menziesia
Ribes hudsonianum	Rib hud	Western Blackcurrant
Ribes lacustre	Rib lac	Swamp Gooseberry

TABLE 3.9-2 (Cont'd)

VEGETATION SPECIES LIST
ABM RIDGE PROJECT AREA (6,400-7,350 FEET ELEVATION)
RAVALLI COUNTY, MONTANA
MAY 1987 AND AUGUST 1990

Scientific Name	Code	Common Name
Ribes viscosissimum	Rib vis	Sticky Currant
Sambucus racemosa	Sam rac	Black Elderberry
Spiraea betulifolia	Spi bet	Shinyleaf Spiraea
Vaccinium globulare	Vac glo	Blue Huckleberry
Vaccinium myrtillus	Vac myr	Dwarf Bilberry
Vaccinium scoparium	Vac sco	Grouse Whortleberry
TREES		
Abies lasiocarpa	Abi las	Alpine Fir
Picea engelmannii	Pic eng	Engelmann Spruce
Pinus albicaulis	Pin alb	Whitebark Pine
Pinus contorta	Pin con	Lodgepole Pine
Pinus ponderosa	Pin pon	Ponderosa Pine
Pseudotsuga menziesii	Pse men	Douglas-fir
LOWER PLANTS		
Marchantia sp.	Mar sp.	Liverwort

Nomenclature follows Hitchcock et al. (1955-1969) and Hitchcock and Cronquist (1973).

western foothills of the Sapphire Mountains, Sapphire rockcress is found at a few proximal locations in Charleys Gulch and at another site about six air miles north of Charleys Gulch. The taxon is considered by the Montana Natural Heritage Program to be critically imperiled globally, as well as critically imperiled in the state, due to extreme rarity and vulnerability to extinction.

The Sapphire rockcress is generally found on steep south or southwest facing slopes at elevations between 4,700 and 5,000 feet, and occurs on light colored calcareous outcrops. Dominant vegetation is sagebrush/grassland or grassland, and all four sites are weedy with populations of spotted knapweed.

In addition to the rockcress, another species of interest, *Linanthus nuttallii* (Nuttall's linanthus) was located at the location of the proposed water storage facilities (Shelly, 1990). This species was formerly listed as "RARE" by the Montana Rare Plant Project (Lesica et al., 1984), but was subsequently deleted (Shelly, 1990).

A small stand (1.4 acres) of western needlegrass (*Stipa occidentalis*) is located in the area of the proposed HRWS and is an example of native mountain grassland, a relatively uncommon ecosystem in this primarily forested region.

NOXIOUS WEEDS

Noxious weeds on the project site include *Centaurea maculosa* (spotted knapweed) and *Cirsium arvense* (Canada thistle). Despite the existing disturbance in the area, neither are abundant as yet. Other weeds regarded by Ravalli County as noxious (sulphur cinquefoil, *Potentilla recta*, and Dalmation toadflax, *Linaria dalmatica*) are not present on the site.

WETLANDS

The proposed mine site enters two wetland areas (Figure 3.9-1) located immediately to the northeast and southwest of the previous ABM Ridge mined area. These wetlands, which total approximately 10 acres, are found in drainage depressions that appear to be maintained in moist conditions by seepage out of the slopes.

The wetland to the east of the ABM Ridge site contains two bog orchids, *Habenaria dilatata* and *Habenaria saccata*, which, while not on protected lists, are uncommon species in wetlands. The limited occurrence of wetlands in the regional landscape makes the occurrence of these bog orchids very infrequent.

TIMBER RESOURCES

Forest habitat types and timber yield capabilities according to Pfister et al. (1977) for the mine vicinity are given in Table 3.9-1 (see Stansbury Holdings, 1990a). Average timber potential is in the subalpine fir/woodrush habitat type and moderate timber potential in the more prevalent types. The HRWS occupies an area that was clear-cut in 1986.

3.10 VISUAL RESOURCES

DESCRIPTION OF STUDY AREA AND PERIPHERY

The Bitterroot Valley is about 100 miles long and averages between 10 and 12 miles wide near the study boundaries. The study area lies within the Broad Valley Rockies Landscape Character Type. The slopes

that form the eastern watershed of the Bitterroot Basin (Sapphire Mountain Range) and the study area, rise from the valley floor with a low angle, from undulating and rhythmic grassland foothills of more or less terraced sides, to a point where heavily timbered, steeper slopes extend dark fingers out to meld with them in a natural landscape continuum. This gradually sloping ascent contrasts greatly with the abruptly rising slopes of the Bitterroot Range on the west side of the valley, which diminishes its visual significance from traveled roadways and densities of people, accordingly.

The Sapphire crestline lies about 30 miles east of the valley, but as a continuous ridge is scarcely so definite and well marked as the summit of the Bitterroots. The ultimate divide is the main range of the Rocky Mountains, but the intermediary ranges, radiating in all directions, form so many separate divides that the central backbone, which only touches the valley near its southern extremity, is lost from sight.

The canyons which enter the valley on the east are not so numerous nor so regularly arranged as are the western affluents. The divides between them rise from the valley with easy gradients, presenting fronts many miles in width that are seamed and scarred with shallow, steep, and irregular gulches, sometimes cutting back several miles in the frontage section of the spur. This eastern watershed has a greater aerial extent than the Bitterroot watershed, but with greater aridity.

VISUAL CHARACTER TYPES

The St. Clair Creek drainage is characterized as a perennial stream drainage with steep, wooded side slopes and is typical of timbered mountainous terrain in the area. ABM Ridge is a relatively flat-topped ridge with steeply sloping sides. Clear cuts in the drainage have removed some of the timber cover. In the project area, timber cover tends to be less dense on south-facing than on north-facing slopes.

The area of the proposed mine has been disturbed by previous mining activity. Vegetative cover has been removed, a road has been built, an area cleared for past milling operations, and mining benches and roads have been cut. The area currently shows the impact of previous mining activity. Some revegetation of disturbed areas has taken place as a result of natural past invasion and seeding pill efforts by the present operator. Approximately 53 acres of areas disturbed by past activities are deemed recovered, and 61.5 acres are unrecovered by Bitterroot National Forest Plan Standards (USFS, 1987d). The reader is referred to Page II-24 of the Bitterroot National Forest Plan for an explanation of unrecovered acre standards (USFS, 1987c).

In all, 9,640 acres exist in St. Clair Creek drainage, of which 5,775 acres (60 percent) are public lands. About 29 percent of public lands in this area can be viewed from a major travel route (U.S. Highway 93) and from Grantsdale, South Hamilton, and areas further south. Due to the distance of the mine site from these viewpoints (background distance of 12-15 miles), no details or textures are seen; mainly contrasts of light and dark. Soil colors, particularly the vermiculite and magnetite deposits in the area are of a darker hue. The terrain contrasts are more gradual around the ABM Ridge site where there is a definite meld of natural openings and existing vegetation. The ore concentrator site and stockpile areas, as planned in 1987, were termed to lie in a variety class "C" landscape, with continuous vegetative cover and little or no variety or pattern (USFS, 1987d).

The proposed mine/concentrator site would also be visible from the west slope of the Bitterroot Valley. Horse Ridge, immediately above the mine site, can be seen on a clear day from the Hamilton vicinity due to its higher elevation and lack of intervening frontal topography to screen it.

VISUAL MANAGEMENT OBJECTIVES

The stated visual management objective for the area is "M," indicating that introduced activities may appear dominant in the scene, but must be patterned after natural occurrences, and be compatible with the natural existing landscape (see USFS, 1974 and USFS, 1987d for further discussion).

3.11 RECREATION

BNF land is important to Ravalli County residents for its recreational and aesthetic value.

Elk hunting is the predominant form of recreation near the project site. The proposed mine is located between the Bitterroot Game Range and Bitterroot Stock Farm on the west and Skalkaho Game Preserve on the east. The isolated, high mountain valley of the mine site area is a migration corridor for elk, and may serve as summer range, winter range, and intermittent calving areas. Two private, traditionally used hunting camps are located on the ridge above the mine.

Skalkaho Mountain and the west boundary of the Skalkaho Game Preserve are approximately one-half mile east of the proposed mine site. The Skalkaho Game Preserve is open to hiking and wildlife viewing. A trail to Skalkaho Mountain offers a mostly scenic view, but the results of past mining are visible. A few people have used the area around the mine for cross-country skiing and trail biking. Firewood gathering occurs along the roads in the area, especially in recently harvested units.

Stony Mountain Wilderness Study Act Area is located one-half mile southeast from the mine site. This area receives light use for semiprimitive recreation.

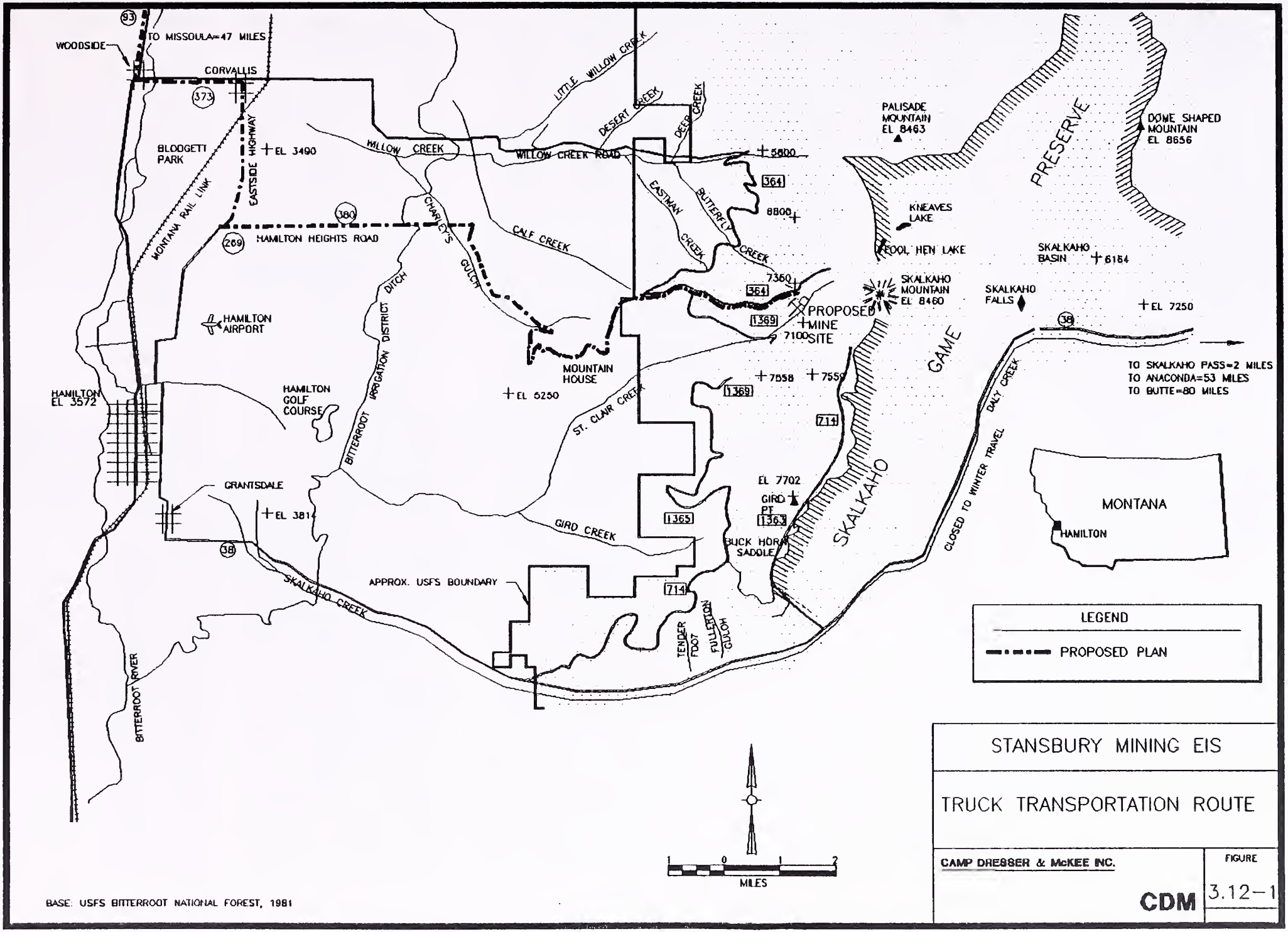
3.12 TRANSPORTATION

As noted in Chapter 2.0, Stansbury Holdings Corporation (1990a) proposes to use a haul route that begins on the existing road on ABM Ridge and initially extends along Forest Service and private roads 11 miles west to Hamilton. Figure 3.12-1 shows the unpaved mine access road as it would traverse BNF Lands (Forest Road #364) and enter private lands in Sec. 21, T6N, R19W. Following this point, the existing route continues to traverse mostly private lands down Charleys Gulch to its intersection with the paved Hamilton Heights Road, the beginning of Ravalli County maintenance responsibility.

The route next extends west to join State Highway 380 on the same right-of-way. It then continues west to State Highway 269 (the East Side Highway), then north 2.5 miles to State Highway 373 at Corvallis, then west to U.S. Highway 93. Trucks continue on to Missoula via U.S. 93, then I-90 on to the Butte vicinity for delivery to the exfoliation plant. Total length of this haul route is approximately 188 miles.

Current conditions on the various sections of this route are as follows (Thompson, 1990):

- ABM Ridge to 4 miles west on Forest Road 364 -- 12 to 14 feet wide, single-lane dirt road, low standard, reconstruction necessary for use by haul trucks.
- Partially graveled road on private lands (Frost-controlled property) -- medium to low standard, owner responsible for maintenance.
- Partially graveled road through Charleys Gulch -- wide, single-lane gravel road, no shoulders, medium standard.


TO MISSOULA=47 MILES
WOODSIDE
CORVALLIS
BLODGETT PARK
EL 3490
EASTSIDE HIGHWAY
MONTANA RAIL LINK
HAMILTON HEIGHTS ROAD
HAMILTON AIRPORT
HAMILTON EL 3572
HAMILTON GOLF COURSE
GRANTSDALE
EL 3814
BITTERROOT IRRIGATION DISTRICT DITCH
CHARLEY'S GULCH
CALF CREEK
MOUNTAIN HOUSE
EL 6250
LITTLE WILLOW CREEK
DESERT CREEK
DEER CREEK
WILLOW CREEK
WILLOW CREEK ROAD
5800
EASTMAN CREEK
BUTTERFLY CREEK
8800
7350
PROPOSED MINE SITE
7100
7058
7550
ST. CLAIR CREEK
GIRD CREEK
EL 7702
GIRD PT
BUCK HORN SADDLE
APPROX. USFS BOUNDARY
SKALKAHO CREEK
TENDER FOOT
FULLERTON GULCH
BITTERROOT RIVER
PALISADE MOUNTAIN EL 8463
DOME SHAPED MOUNTAIN EL 8656
PRESERVE
KNEAVES LAKE
POOL HEN LAKE
SKALKAHO BASIN
6164
SKALKAHO MOUNTAIN EL 8460
SKALKAHO FALLS
EL 7250
GAME
SKALKAHO
DALY CREEK
CLOSED TO WINTER TRAVEL
TO SKALKAHO PASS=2 MILES
TO ANACONDA=53 MILES
TO BUTTE=80 MILES
MONTANA
HAMILTON
LEGEND
PROPOSED PLAN
0
1
2
MILES
BASE: USFS BITTERROOT NATIONAL FOREST, 1981
STANSBURY MINING EIS
TRUCK TRANSPORTATION ROUTE
CAMP DRESSER & McKEE INC.
CDM
FIGURE
3.12-1

- Paved Hamilton Heights Road and west including State Highway 380 -- double-lane, paved road, fair condition, current bridge load limit 5 tons. Ravalli County plans to replace the bridge in the near future.

- East Side Highway and State Highway 373, in Corvallis vicinity -- double-lane, light pavement, no shoulders, good condition and well-maintained.

- Corvallis to Missoula, U.S. Highway 93 - excellent condition and well-maintained.

- Missoula to Butte, I-90 -- excellent condition and well-maintained.

3.13 SOCIOECONOMICS AND LAND USE

LOCAL ECONOMY, EMPLOYMENT, INCOME, AND LAND USES

Economic Trends

Ravalli County's economic trends have mirrored those of the State of Montana in many ways during the past 20 years. The 1970s exhibited healthy economic expansion. By the 1980s, however, this economic growth had slowed. Much of the following information is adapted from Polzin (1989) and the University of Montana, Bureau of Business and Economic Research (1990a).

Per capita (per person) income increased 5.5 percent per year during the 1970s, yet only 0.1 percent per year during the 1980s. Comparisons with the rest of Montana show that Ravalli County's per capita personal income ranks 48th out of the 56 counties. Of the others nearby, Flathead County is 29th, Missoula County is 30th, and Mineral, Lincoln and Sanders counties are 54th, 55th, and 56th respectively. While the growth rate in Ravalli County for both population and total personal income have risen slightly (over 1.5 percent per year) since 1980, the per capita increase is negligible; the individual resident has almost no more money to spend today than in 1980. The economic situation in the six western counties and Montana as a whole has been quite similar. Table 3.13-1 shows the performance of three general economic indicators since 1970, and Ravalli's relative position to Montana and the six western counties.

In Ravalli County, only 44 percent of personal income in 1987 was derived from labor, compared to 66 percent statewide (Table 3.13-2). More than half the County's income was from 1) dividends, interest, and rents, 2) transfer payments (mainly Social Security and military and civilian retirement), and 3) Medicare. Residence adjustments, the remaining portion of income, are wages earned in another county or state by individuals who reside permanently in Ravalli. From 1980 to 1987, residence adjusted income fell 2.6 percent. During the same period, residence adjusted income for the state of Montana increased 1.6 percent -- 4.2 percent over the figure for Ravalli County. This decrease in residence adjusted income mirrored the sluggish U.S. economy during the recession of the early 1980s. Direct income to Ravalli residents from sources outside the county decreased 19 percent from 1970 to 1987.

Even though government transfer payments increased more rapidly than any other income component (Table 3.13-1) in both Ravalli County and Montana, Ravalli's per capita income for persons 65 and older is still $1,000 below Montana's average. Per capita income for all Ravalli citizens was 82.5 percent of the statewide average and 88.8 percent of the six neighboring counties in 1987 (Table 3.13-1).

TABLE 3.13-1

SELECTED GENERAL ECONOMIC INDICATORS
RAVALLI COUNTY, SIX WESTERN COUNTIES,
AND MONTANA
1970, 1980, and 1987

	1970	1980	1987	Average Annual Rate of Change ---(Percent)--- 1970-80	1980-87
Population (Persons)					
Ravalli County	14,409	22,493	25,200	4.6	1.7
Six western counties	140,282	177,140	188,700	2.4	0.9
Montana	694,409	786,624	809,500	1.3	0.4
Per Capita Income (1987$)					
Ravalli County	$ 5,941	$ 10,098	$ 10,143	5.4	0.1
Six western counties	6,583	11,564	11,423	5.8	0.2
Montana	7,126	12;315	12,292	5.6	0.0
Nonfarm Labor Income (millions 1987$)					
Ravalli County	$ 46.1	$ 99.6	$ 107.4	8.0	1.1
Six western counties	717.2	1,483.2	1,444.2	7.5	-0.4
Montana	3,302.6	6,608.7	6,093.1	7.2	-1.2
Total Personal Income (millions 1987$)					
Ravalli County	$ 86.4	$ 228.6	$ 255.8	10.2	1.6
Six western counties	923.5	2,048.4	2,155.2	8.3	0.7
Montana	4,968.5	9,711.1	9,946.4	6.9	0.3

Source: U.S. Department of Commerce, 1989.

Note: The six western counties are Flathead, Lake, Lincoln, Mineral, Missoula, and Sanders.

TABLE 3.13-2

PERSONAL INCOME BY MAJOR COMPONENT
RAVALLI COUNTY AND MONTANA
1970, 1980, AND 1987
---Millions of 1987 Dollars---

	1970	1980	1987	Average Annual Rate of Change ---Percent--- 1970-80	1980-87
Ravalli County					
Total Personal Income	**$86.4**	**$228.6**	**$255.8**	10.2	1.6
Dividends, interest and rents	17.3	56.5	67.2	12.6	2.5
Transfer payments	14.6	45.4	61.9	12.0	4.5
Residence adjustment	6.0	27.5	22.9	16.4	(2.6)
Labor income	51.2	105.2	111.9	7.5	0.9
Montana					
Total Personal Income	$4,968.5	$9,711.1	$9,946.4	6.9	0.3
Dividends, interest and rents	692.6	1,644.2	1,979.0	9.0	2.7
Transfer payments	554.2	1,488.6	1,852.5	10.4	3.2
Residence adjustments	(2.4)	10.0	11.3	NA	1.8
Labor income	3,902.4	6,995.2	6,546.0	6.0	(0.9)

Source: U.S. Department of Commerce, 1989.

During public meetings, issues were raised as to the socioeconomic impacts of increased employment and population. To fully address these concerns, details on Ravalli County's economic sectors, including salaries, employment, and values of associated lands, are presented. These data provide a basis from which to assess the socioeconomic impacts that the proposed action would have on Ravalli County.

Employment Sectors and Income

Wage and Salary Income — Average Annual County Salary: $12,600

Wage and salary income in Ravalli County provides the largest block of personal income dollars in the economy. As noted previously, it amounts to 44 percent of total personal income for Ravalli, compared to about 66 percent for the State. Table 3.13-3 shows the percentage of 1987 dollars that each job sector category contributes and how that percentage has changed since 1970. It also shows the number of jobs in each category and the average yearly income per job. The number of jobs includes full and part-time workers. Sole proprietorships (usually small, family-owned) are also considered. Of the 8,879 total jobs in the county in 1987, 5,543 are wage and salary employment, and 3,436 are proprietorships. Comments by job sector regarding local economy, employment, income, and implications for land use are given below.

Government — Average Annual Salary: $18,100
Federal: $25,100
State and local: $16,600

The largest single contributor of labor dollars in Ravalli County is government. State and local government employees (highway workers, police, school teachers, and others) hold 820 positions and receive 12.2 percent of the labor dollar. Federal workers, mainly employed by the USFS, BNF (about 300), and the Rocky Mountain Lab (about 150) hold another 463 jobs and receive an additional 10.4 percent of the labor dollar. The fact that average income for these Federal jobs is almost twice the County average is attributable to the number of professional and advanced-degreed persons employed. Although the Forest Service does hire seasonal and semi-skilled workers locally, many vacancies are filled by non-Ravalli Residents, because these positions often are open only to those with Federal employment status. Since 1970, Ravalli County has lost 100 Federal jobs, and gained 342 State and local jobs. The increased number in State and local government employment closely parallels the County's population growth, all of which have been relatively stable since 1980.

Of the 1.5 million acres in Ravalli County, 75 percent (1.125 million acres) is owned by the government. The BNF accounts for more than 1.1 million acres. Sula State Forest, school sections, and game preserves account for 40,000 acres. Two major types of revenues generated by public lands, Payments in Lieu of Taxes (PILT) and National Forest receipts, provided $900,000 to Ravalli County in 1987.

Services — Average Annual Salary: $12,400

The services sector, which includes legal, medical, and accounting services, motels, automotive and other types of repair shops, and social and educational services, provides the second largest percentage of dollars and the largest number of jobs. It is also one of only two sectors to show any significant increase since 1980. This area is characterized by many small businesses, operated by one or a few professionals with few office staff. Part-time work is common in bookkeeping and tax consulting.

No data specific to the market or taxable values of land associated with legal, medical, and accounting services were available.

TABLE 3.13-3

AVERAGE INCOME BY JOB SECTOR, RAVALLI COUNTY, 1987

Sector of Economy	Average Income ($)	Number of Jobs	Job Sector % of Income	Yearly Rate of Change (1970-1980)	Yearly Rate of Change (1980-1987)
Ravalli County	12,600	8,879	100.0	7.5%	0.9%
Government					
Federal Civilian	25,100	463	10.4	3.0%	(1.5%)
Military	6,200	148	0.8	N/A	N/A
State & Local	16,600	820	12.2	9.7%	1.2%
Total Government	18,100	1,431	23.4	N/A	N/A
Services (Legal, Accounting, & Others)	12,400	1,892	21.1	8.9%	4.8%
Manufacturing					
Lumber & Wood Products	N/A	N/A	11.3	7.1%	0.4%
All Other	N/A	N/A	2.8	19.3%	13.5%
Total Manufacturing	18,200	869	14.1	N/A	N/A
Retail Trade	9,700	1,303	11.3	6.8%[a]	(0.9%)[a]
Transportation & Public Utilities	20,300	517	9.4	N/A	N/A
Construction	16,100	575	8.3	N/A	N/A
Agriculture	3,700	1,240	4.0	0.9%	(3.1%)
Finance, Insurance & Real Estate	6,400	653	3.8	7.6%	0.2%
Wholesale Trade	20,900	162	2.9	N/A	N/A
Mining	16,700	18	0.3	13.0%[b]	(9.9%)[b]

[a] Includes wholesale trade.
[b] Includes mining and railroad employees.

N/A - Data not available
Source: University of Montana, Bureau of Business & Economic Research, 1990a.

Manufacturing Average Annual Salary: $18,200

About 14 percent of labor dollars and about 10 percent of available jobs are in manufacturing. Average income in the manufacturing field is almost $6,000 above the County average, and for this reason, manufacturing jobs are desirable to many. Most of these positions are in the wood products industry -- lumber mills and cabinet manufacturing are examples. Although the larger mills are facing economic problems, some smaller operations, such as custom planers, have opened since 1970. Position requirements range from skilled to unskilled.

The non-timber segment of manufacturing, though small, has been the only portion of the economy to maintain rapid expansion. Recreational equipment appears to be the centerpiece of this industry. Since 1980, dollars generated by this sector have doubled and now surpass both the agriculture and the finance-insurance-real estate sectors. While these two latter categories have declined or shown no gain, non-forest products manufacturing is currently growing at the annual rate of 13.5 percent.

New manufacturing accounted for 2 to 4 percent of property taxes in Ravalli County in 1988. No data specific to the market or taxable values of land associated with manufacturing were available (Montana State Department of Revenue, 1989).

Retail Trade Average Annual Salary: $9,700

The retail industry is the third largest employer in the County and contributes over 11 percent of the labor dollar. Many of the retail jobs are semi-skilled, low-paying, and often part-time. An average income almost $3,000 below the County average supports this assertion. Women and young persons, often new entrants to the job market, hold many of these positions. The retail market sector generally paced the County's rapid population growth of the 1970s, but since 1980 has been declining in dollars per year contributions. About 30 jobs have been added since 1980.

Market and taxable values of commercial land increased 5 percent from 1987 to 1988 (Montana State Department of Revenue, 1989).

Transportation and Public Utilities Average Annual Salary: $20,300

Although this is one of the smaller employment sectors, it has shown steady growth, doubling the number of jobs since 1970 and increasing its share of the total income dollar to 9.4 percent. Often these are skilled trade positions. With an average annual income of over $20,000, these jobs are not only desirable, but usually locally accessible.

The market and taxable values of lands associated with public utilities remained relatively constant from 1987 to 1988 at $17.42 million in 1988 (Montana State Department of Revenue, 1989).

Construction Average Annual Salary: $16,100

This job category is quite similar in size and growth to Transportation and Public Utilities, supplying 8 percent of the labor dollar and providing 575 positions. Construction workers range from master craftsmen to unskilled laborers. The average annual salary is lower than might be expected because of temporary layoffs, but still is $3,500 higher than the County average.

Although no data were available for the values of land associated with the construction industry as a whole, figures were obtained for land values associated with remodeling. From 1987 to 1988, the market value of land associated with remodeling increased 43 percent, while the taxable value increased 148 percent (Montana State Department of Revenue, 1989).

Agriculture Average Annual Salary: $3,700

Of the 1,240 jobs listed as agricultural, 1,030 are shown as sole proprietorships. Only 210 positions are listed as wage earning. Since 1970, the number of proprietors has almost doubled while wage earners have remained at the same level (212). The large number of proprietors coupled with the agriculture's extremely low annual wage and the fact that agriculture contributes less than half the labor income it did in the 1970s, suggests that agriculture in this area is now a part-time profession for many persons. Since 1980, agricultural dollars have declined more than 3 percent per year. While many reasons, local and international, contribute to this decline, subdivision of the larger land holdings and the subsequent demise of agriculture as a full-time profession are likely key factors.

Land devoted to agriculture and agricultural products accounted for 41 percent of land in Ravalli County in 1988. From 1987 to 1988, land values continued to decline. The market and taxable values of all agricultural lands including irrigated, non-irrigated, grazing, and wild hay decreased 1.4 percent. Values of land used for livestock production decreased 4 percent, and values of land used for farm machinery decreased 10 percent. Only land values for one-acre farmsteads increased; both market and taxable values rose 5 percent (Montana State Department of Revenue, 1989).

Finance, Insurance, and Real Estate Average Annual Salary: $6,400

Although a respectable number of persons work in this labor sector (653), it contributes the third smallest amount of labor dollars, and the second lowest annual salary (half the county average). Factors leading to this situation include a large number of part-time workers and income often based on sales and commissions. This portion of the economy experienced average performance during the 1970s and negligible (0.2 percent per year) growth during the 1980s.

No data specific to the market or taxable values of land associated with finance, insurance, and real estate were available.

Wholesale Trade Average Annual Salary: $20,800

This job sector is the second smallest while having the second highest annual income. While contributing only 2.9 percent of the total income dollar, it has been steadily increasing its share since 1970.

No data specific to the market or taxable values of land associated with wholesale trade were available.

Mining Annual Salary: $16,700

Mining is not a major industry in Ravalli County. Employment since 1970 has ranged between 10 and 38 persons, but is usually 15 to 20 persons in any given year. Even though only a few persons are employed, their yearly income is $4,000 above the County average. Ravalli's mining boom seems to have peaked around 1981, when 38 persons earned a total of $661,000. Specialized knowledge is required in some mining positions, but many jobs are typical of road construction work: heavy equipment operation and maintenance.

No data specific to the market or taxable values of land associated with mining were available.

Unemployment

According to Hamilton Job Services, the rate of unemployment in Ravalli County in 1990 is relatively high at 7.3 percent. The Ravalli work force totals 10,476 -- 9,707 of whom are employed and 769 of whom are unemployed. The occupational distribution of job applicants on file at Hamilton Job Services shows heavy emphasis on the service industry and in construction (O'Leary, 1990).

Dividends, Interest, and Rents

The second largest segment of the Ravalli economy is derived from dividends, interest, and rents, which accounts for 26.3 percent of total personal income. This sector accounts for 6.5 percent more dollars in Ravalli than the Montana average. Growth rate here was 12.5 percent per year in the 1970s, and 2.5 percent per year in the 1980s. While this is still a healthy expansion, it has fallen slightly behind the State's rate of growth.

Government Transfer Payments

Government transfer payments are income payments essentially received as grants: about 90 percent are Social Security and other Federal retirement checks. Transfer payments account for almost 25 percent of all income in Ravalli County, and have been the fastest growing segment of the economy, showing steady expansion throughout the 1980s.

Details regarding transfer payments (Table 3.13-4) help to explain the prominent economic role of retirees in the county. However, data on per capita payments to retirees are not accessible in public files. Therefore, data must be extrapolated from other sources such as age. The percentage of dividend, interest, and rent income collected by retirees is also unknown.

Ravalli County has long been considered a retirement haven. With 13 percent of the population over age 65 (about 3,500 people), the county average is slightly higher than the State (and national) average of 12.2 percent. Because many people are eligible for benefits at age 62 or 60 (and sometimes earlier), the 60 years old age threshold may be a realistic indicator. About 4,500 persons, age 60 and over, reside in Ravalli; about 400 to 500 more than would be expected for the same size population elsewhere in Montana. Although this is not a large difference, it does reduce the average annual income based on transfer payments from $16,000 to $12,500. The retiree likely receives an annual income that is greater than or equal to the average worker in Ravalli County.

Residence Adjustment

The fourth component of personal income is residence adjustment, reported as the amount of wages earned by a person outside their home county. About $22.9 million, or 8.9 percent of total personal income in Ravalli County (Table 3.13-2), is primarily derived from persons commuting daily to Missoula (in Missoula County).

The residence adjustment for the county quadrupled in the 1970s, but since 1980 has been losing 2.6 percent per year.

TABLE 3.13-4

TRANSFER PAYMENTS BY MAJOR COMPONENT
RAVALLI COUNTY
1970-1987
(Thousands of Dollars)

	1970	1980	1987
Total Transfer Payments	7,229	32,923	63,492
Government payments to individuals	6,864	31,181	60,148
Retirement and disability payment	4,640	21,487	39,917
Social Security benefits	3,271	14,026	24,932
Railroad retirement benefits	183	693	1,133
Federal civilian retirement payments	599	3,699	7,214
Military retirement payments	318	1,777	2,837
State and local government retirement payment	154	872	1,899
Worker's compensation payment	115	420	1,902
Medical payments	687	4,188	11,825
Income maintenance payments	385	1,717	3,276
Unemployment insurance benefit payment	279	1,870	2,380
Veterans' benefit payment	843	1,759	2,595
Federal education & training assistance pay	(NA)	150	141
Payments to nonprofit institutions	198	1,072	1,422
Business payments to individuals	167	670	1,922

Source: U.S. Department of Commerce, 1989.

Note: (NA) Data not available.

Taxation

The State of Montana's taxation philosophy is to raise the largest single portion of revenues, about 42 percent, from income and property taxes. The other 58 percent is raised from many sources, including Federal government payments (24 percent), interest from trusts (11 percent), user fees (9 percent), liquor store operations (3 percent), and other sources (11 percent).

The total budget for any state is dependent upon many factors. The area, population, and level of services desired by the population all have a significant effect on the budget. Maintenance of roads, rural fire districts, police patrol, and rural schools are all more expensive per person if a city or county is too small to take advantage of economies of scale. For example, Montana has 208 elementary and secondary education employees per 10,000 population, whereas the national average is only 185.

To put Montana into perspective, it is the 4th largest state geographically, with the 5th smallest population. It ranks only 40th in per capita income, almost $4,000 less than the national average, while being 29th in amount of taxes collected per person. Montana's state and local governments expenditures rank 24th of the 50 states.

Taxation in Ravalli County follows State trends. Property taxes accounted for 40 percent of County revenues in 1988. Other sources of revenue included direct payments from the Federal government (17 percent), 71 percent of which were Payment in Lieu of Taxes, State payments (17 percent) including indirect Federal funds, motor vehicle taxes, and related fees and charges (12 percent), and other sources (14 percent).

Indirect and direct payments from the Federal government account for 20 percent of all revenues received by Ravalli County. Without these funds, Ravalli County would run a deficit of $627,211 (Ravalli County, 1990). These funds, which are generated from timber sales, grazing leases, deferred taxes, and other payments on Federal lands, amount to 24.4 percent of the State and local revenue.

POPULATION

Population in Ravalli County boomed in the 1970s, increasing from approximately 14,500 to about 22,500, an increase of over 50 percent (Table 3.13-5). However, in the 1980s growth slowed significantly. The County gained only about 3,000 people from 1980 to 1987, and at present has about 25,300 people. (The 1990 Census data will not become available until 1991.) At the same time, Montana's population grew about 15 percent in the 1970s, but slowed to a total 2 percent growth in the 1980s.

The age distribution of the Ravalli population is of particular interest since many people locally believe the County is becoming a retirement community. Table 3.13-5 shows population of four age groups and the percentage of the population in these age groups.

This table clearly shows shifts in population since 1970. However, a shift towards a community predominated by retirees is not evident. First and most obvious, there are more persons in every category due to the overall increase in population. Second, the only increase in population percentage during the period from 1970 to 1987 occurred in the 20 to 49 age group, which now makes up 44 percent of the total population. This group has expanded 13.5 percent since 1970 and more than doubled its actual number. Each of the other age groups experienced a decrease in population relative to total population. Concurrently, the proportion of retirees did not increase similarly, but declined in percentage. Ravalli County is considered an attractive place to retire, and it does have a larger

TABLE 3.13-5

POPULATION OF RAVALLI COUNTY

				Percentage of the Population in Age Group		
Year	1970	1980	1987	1970	1980	1987
Age Group						
19 and under	5,470	7,500	7,300	38.0	33.5	28.4
20 to 49	4,390	8,500	11,300	30.5	38.0	44.0
50 to 64	2,395	3,400	3,500	16.6	15.2	13.6
65 and over	2,154	3,000	3,600	15.0	13.4	14.0
Totals	14,409	22,400	25,700			

Source: University of Montana, Bureau of Business and Economic Research, 1989.

percentage of retirees than the rest of Montana, but by actual numbers it has only about 400 to 500 more persons 65 and over than would be expected by State or national figures. It is also interesting to note that the State of Montana's retiree age group segment has increased from 9.9 percent to 12.2 percent during the same time period that Ravalli County's declined from 15 percent to 14 percent. These data suggest that working people are not moving out of the Bitterroot Valley--they are moving in.

Other data show that Ravalli County population in 1987 is split almost precisely 50 percent male, 50 percent female. By race, 98 percent are white, with 1 percent or less reported as American Indian, Hispanic, Asian, and others (U.S. Department of Commerce, 1982).

HOUSING

Information on housing was summarized and reproduced from that previously gathered by Stansbury Holdings Corporation (1990a), as confirmed and updated by telephone interviews with local officials (G. Anderson, 1990) and realtors, and from university sources (University of Montana, Bureau of Business and Economic Research, 1990). In 1980, there were 8,771 year-round housing units in the county. Over 88 percent of these units were considered to be in rural areas. Between 1970 and 1980, 3,593 units were added to the County's housing stock, indicating a relatively high level of newer units. Only 1,372 housing units were considered urban in 1980. By 1988, approximately 9,900 housing units were estimated. Between 1980 and 1988, only about 1,129 units were added to the County's housing stock.

Single Family

Seventy-two percent of the housing units in Ravalli County in 1980 were single-family dwellings; 15.5 percent of these were mobile homes. These figures compare to a statewide average of 12.9 percent for mobile homes as a percentage of single family dwellings. Nearly half of the county's housing units have 3 or more bedrooms (49.7 percent). Household size has appeared to decrease from 2.8 to 2.5 persons per household from 1980 to 1988.

Rental Units

Rental units continued to be difficult to locate for in-migrants. Realtors remarked upon a lack of availability of 3 bedroom units. In early July 1990, 14 rentals, including houses, mobile homes, and apartments, were listed in the Ravalli Republic, a Hamilton newspaper. These units were located throughout the valley. According to various local sources, housing availability diminishes in the summer due to returning residents and vacationers.

Mobile Homes and Temporary Housing

Five mobile home and recreational vehicle (RV) parks are located within eleven miles of Hamilton, representing 187 hookups and offering the full array of domestic facilities. Three additional parks exist at Darby and Connor. Most of these were listed as open from May to October, although three, including the largest, were open year-round. Further, many of the local motels are equipped with kitchenettes and will negotiate for longer-term occupancy. Availability of mobile home, RV, and motel accommodations fluctuate seasonally: June, July, and August currently experience the highest occupancy rates. Another milder occupancy surge occurs in the fall during hunting season.

Real Estate Values

A review of the recent Bitterroot Valley Real Estate Directory (1990) and Ravalli County Multiple Listing Service (1990) directory confirms that there are a wide variety of homes and undeveloped lots are for sale county-wide. Interviews with local realtors (Bonnette, 1990) confirmed that the housing market has been improving steadily since the 1980s. Prices generally ranged from $45,000 to $150,000 for single-family units with smaller acreage. The average price for a 3 bedroom home in Hamilton is approximately $70,000. Undeveloped land in rural areas is reportedly selling for $2,000 to $5,000 per acre.

SERVICES

Community services reviewed for this EIS include schools, medical and elderly care facilities, public, fire, emergency services, and utilities. Again, information provided by Stansbury Holdings Corporation (1990a) generally was updated and confirmed by other written sources and local interviews. Services in the City of Hamilton and County of Ravalli generally are deemed adequate at present (Williamson, 1990; Allen 1990).

Schools

Six school districts comprise the county, and include private Christian schools in Pinedale and Hamilton. For purposes of this discussion, it is assumed that if any mine employees moved to the county as a result of the project, they would tend to move within easy commuting distance of the mine. Therefore, the immediate area of influence for school districts would include the Victor, Corvallis, and Hamilton districts.

Each of the districts has an elementary (K-8 grades) and a high school. Average enrollment has remained fairly steady in the Hamilton district in the mid-1980s. During the 1986/87 school year, enrollment reached a low of 1,276 students, but has steadily increased since that time. During the 1989/90 school year, enrollment in elementary and high school combined was 1,315 students (Hamilton School District, 1990).

In the Victor district, elementary enrollment has remained fairly stable, fluctuating by only seven students between 1982 and 1987. High school enrollment has declined by seven students in this time period.

The Corvallis District has achieved fairly stable enrollments, fluctuating by some twenty students since 1982 in each of the two respective schools. This district expanded its high school in 1982, and constructed a new K-3 elementary building in 1986.

Medical/Elderly Care

The Marcus Daly Memorial Hospital in Hamilton is a 48-bed facility established in 1975. The hospital offers general acute care including surgery, emergency room, coronary and intensive care, pediatrics, nursing, and obstetrics. There are no long-term mental health, drug, or detoxification facilities; instead, interim 24-hour care is provided until an individual can be transferred to another facility, generally to a hospital in Missoula.

Two Missoula hospitals, Community and St. Patrick's, offer a full range of medical services 47 miles north of Hamilton. These services include CAT scan, kidney dialysis, and premature infant care. Ambulance services in Stevensville, Darby, and Hamilton are dispatched out of the County Sheriff's

office and received at the hospital. Missoula Life Flight from St. Patrick's Hospital provides air ambulance to remote forest lands.

There are two nursing homes in Hamilton, and one in Stevensville.

Police/Fire/Emergency Services

The City of Hamilton currently employs a police force of 8 for its 2,661 people. The norm is two officers per 1,000 people, so the staffing level is easily able to handle the 250 calls per month now received. No high crime rate or transient problem is reported for Hamilton.

The County Sheriff's office is responsible for policing rural areas of the County, including the mine site. As of July 1990, the force consists of 16 officers for 25,000 people in a county-wide area.

The Darby District of the USFS has wildland fire suppression responsibility for the project since the mine and HRWS both would be on National Forest lands. The fire management officer for the District described the project area as a relatively low wildland fire hazard area due to the open geography and limited quantity of downed fuels.

The County Disaster and Emergency Services (DES) office coordinates disaster and rescue efforts, dispatched out of the County Sheriff's office and coordinated by radio communications. All rural fire districts in the county have mutual aid agreements, and a volunteer search and rescue office is located on Fairgrounds Road, Hamilton.

No formal training for search and rescue has occurred in the County to date. The DES office reportedly published a plan for emergency coordination in 1986.

Utilities

Solid Waste Management. Two privately owned landfill sites currently exist in the county: a site at Victor that serves the entire valley exclusive of Darby, and a site in Darby. Two private vendors, Bitterroot Disposal and Mid-Valley Disposal, collect and haul refuse. According to the county sanitarian (J. Anderson, 1990), both sites will soon be closed, with transfer stations only at Victor and Darby and eventual disposal at the BFI site near Missoula.

In 1987, an application was before the State Solid and Hazardous Waste Bureau to license an 80-acre commercial landfill near Corvallis. It was unclear at that time whether that application would be approved. No updated information on this matter was available in 1990.

Water and Sewer. Water and sanitary services are not currently available in the mine site vicinity, which is outside existing service areas. A small spring near the mine site is proposed for future development for project use.

Planning Services. Ravalli County has adopted comprehensive plans in the past, notably an initial comprehensive plan in 1981 (University of Montana, School of Business Administration, 1989). While these provide philosophical statements, they do not currently serve as specific guides to growth. Ravalli County's planner and sanitarian are responsible for all long-range planning and environmental health permitting, as well as subdivision review.

The City of Hamilton does not currently employ a full-time planner, but does contract for occasional planning services. No comprehensive plan has been adopted. The City has a zoning ordinance that it is currently updating, addressing land within its jurisdiction (generally, the City limits). With proposed movement of the Stansbury exfoliation plant to Butte, the mine/transport routes would likely not come under the jurisdiction of the City of Hamilton (Williamson, 1990).

SOCIAL STRUCTURE

Information concerning social characteristics was gathered predominantly through informal interviews (local officials, business leaders, and representatives of service groups) and review of published materials during April, 1987. In particular, one document, "Land Use Planning: A Rural Focus" (Carlson, 1977), was relied upon to document local county attitudes, because it included results of a county-wide survey with a high response rate -- the only one of its kind. Furthermore, its findings still appeared fairly accurate in 1987 as corroborated by personal interviews at the time (Stansbury Holdings Corporation, 1990a). Other statements have been verified through attendance at local meetings, and through telephone and personal contacts with local residents and officials by the EIS Team during 1990.

Social Groups

From the survey of the local economy presented in Section 3.13, the following observations were made concerning social groups in Ravalli County. These groups are assessed based on theory that constant behavioral factors (in descending order of importance as shown below) guide a person's feelings about economic development and environmental protection:

1. Economic self-interest - food, shelter, secure income source
2. Social self-interest - companionship, group acceptance, political influence
3. Personal value judgements - feelings about economy, environment, political systems
4. Concerns for natural systems - quality of life, preservation, and protection of environment

With these factors in mind, the following groups are noted:

Retirees - This group has become a dominant political force in the county -- especially during the 1970s and early 1980s. With sufficient fixed incomes, much leisure time, and general good health and social status, preservation of existing quality of life appears to be a major concern. Persons 65 and older currently number about 3,500 or 14 percent of Ravalli County's population (Table 3.13-5).

Working Age Adults - This group includes most of the income sectors discussed previously, and persons aged 20 to 49 currently number about 11,000, or 44 percent of the County's population. The group has grown substantially in number since 1980, and risen from 38 percent in 1980 to the current 44 percent. This group is generally in favor of economic development of any type, since it means direct or indirect prosperity and increased income. Miners, loggers, and truck drivers seem especially to favor a mining proposal. To others (store clerks, insurance sales people, and similar service occupations), more business and more people mean greater prosperity and security. However, a major development proposal which is perceived to affect quality of life adversely would encounter some opposition, even from the working segment.

Government - According to agency laws, regulations, guidelines and policy, this major income segment must deal fairly and objectively with any development proposal, be they Federal, State, or local. Nonetheless, most persons in this segment are County residents as well, and must deal with positive or negative effects of any development proposal on income, social status, quality of life, and environmental preservation.

Others - Other groups and individuals, organized and nonorganized, minor in number and influence, will, nonetheless, respond to the development proposal and this EIS. From a social perspective, the three groups noted previously appear dominant.

The following subsections supply additional comments regarding local values and attitudes.

Values

In general, most residents have strong ties to the county and leave predominantly because of the lack of job opportunities. The natural beauty of the region and recreational potential are important to most county residents. Environmentally safe industry is generally supported, although two strong vocal factions -- one pro-development, the other pro-environment -- have been polarized over major past proposals facing the County.

The area from Florence and north toward Missoula has absorbed much of the County's recent growth. Large numbers of commuters in Ravalli County are dependent on Missoula-area employment. The Stevensville community is probably equally comprised of commuters and persons employed in the Bitterroot Valley. Victor is characterized by its traditional Bitterroot population and is relatively stable in social structure. The Hamilton area has also absorbed much of the county's growth during the 1970 to 1985 period, with many new businesses from small shops to chain stores locating in Hamilton. Much of the surrounding population has been attracted by the convenient shopping. Darby, although it has experienced little overall growth, has seen some changes in land ownership, with new, wealthy landowners buying some of the older, scenic ranches.

The only social problems identified during 1987 interviews were the lack of jobs in the County, and a related over-reliance on the residential tax base due to lack of industry.

3.14 CULTURAL RESOURCES

ARCHAEOLOGY

A cultural resource inventory of the previous Interim Stockpile Site in Charleys Gulch (Sec. 19, T6N, R19W), the previous Exfoliation Plant site by Hamilton near the Fairgrounds (Sec. 30, T6N, R20W), and in the vicinity of the historic mine and concentrator site (Sec. 24, T6N, R19W and Secs. 19 and 20, T6N, R18W) was conducted by the USFS in 1987. This inventory comprised a thorough literature search and field survey undertaken by Forest Service personnel and a representative of the Salish Cultural Committee. (The Salish people traditionally inhabited the Bitterroot Valley). The cultural resource inventory was based on the survey strategy outlined in the "Prehistory of the Lolo and Bitterroot National Forests: An Overview" (McLeod and Melton, 1986). One prehistoric site (24RA243, Stone Features/Religious Site), one historic site (24RA244, Historic Dwelling/Hard Rock Mine), one prehistoric isolate (BIF-87-3), and one historic homestead (24RA38) were discovered and recorded (USFS, 1987e). The Interim Stockpile site and the Exfoliation Plant site were alternative sites, but are no longer in Stansbury's Proposed Plan (Hinck, 1990).

Site 24RA243 consists of two circular stone features possibly associated with prehistoric/historic Native American religious activities. Site 24RA243 may qualify for inclusion on the National Register of Historic Places (NRHP), following the guidelines in the National Register Bulletin 38. The site is located near the proposed Interim Stockpile, which has been dropped as an alternative stockpile site.

The prehistoric isolate (BIF-87-3) consists of a projectile point fragment (mid-section of a biface) of green chert, also found in the vicinity of the Interim Stockpile site. This site has been determined to be not eligible for the NRHP.

Historic site 24RA244 consists of a collapsed adit, log cabin, spring box and outhouse in the vicinity of the historic mine and concentrator. The structure has been modified and does not appear to qualify for the NRHP.

The historic homestead site, 24RA38, is located near the Interim Stockpile. Based on interviews with the present landowner and archival research at the Ravalli County Courthouse, the Forest Service, in consultation with the Montana SHPO, determined the site is not eligible for the NRHP.

Three modern houses in the vicinity of the former Exfoliation Plant site near the Fairgrounds were not formally recorded because they are not 50 years old, not exceptionally significant, and do not exhibit interesting or distinctive architectural features.

3.15 NOISE

Baseline noise conditions at the proposed mine site have not been monitored. Baseline noise conditions in rural areas are typically in the neighborhood of 40 decibels (dBA). Levels may occasionally rise due to the following situations in the current setting (see U.S. Bureau of Land Management, 1983; U.S. Bureau of Land Management, 1984; and MDSL/USFS, 1982):

Normal conversation (e.g., hikers)	60 dBA
Suburban residential area (e.g., auto traffic, conversation from hunters or fishermen)	70 dBA
Heavy truck traffic (e.g., logging trucks)	82 dBA
Chain saws, heavy equipment (e.g., logging)	85+ dBA

4.0 ENVIRONMENTAL CONSEQUENCES

The anticipated impacts on the environment of the alternatives identified for the Western Vermiculite Project are discussed in this section. The alternatives considered, as described in Chapter 2.0 are:

- Alternative 1 - Stansbury's Proposal
- Alternative 2 - Stansbury's Proposal with Modifications
- Alternative 3 - No Action Alternative

Alternative 1 is Stansbury's proposal and it assumes that any mitigation measures identified in the proposal would occur as described. Alternative 2 consists of a series of modifications to the Stansbury proposal which have been developed to diminish or avoid potential adverse environmental impacts. Alternative 3 is the No Action alternative and describes any effects derived from rejection of the Western Vermiculite Project permit application.

Effects are characterized as direct, indirect, or cumulative. Direct effects are effects caused by the action and occur at the same time or place. Indirect effects are induced effects not immediately caused by the action, but which may occur later in time or in a different location, or which may affect another environmental component. Cumulative effects result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions.

4.1 METEOROLOGY AND CLIMATE

No changes to either meteorology or climate are expected to occur from the Western Vermiculite Project.

4.2 AIR QUALITY

Air quality is a comprehensive term which includes both aesthetic and health-based considerations. In this section, only those aspects of air quality that relate to the aesthetics and ambient air quality standards are discussed. Health effects from fiber emissions are discussed primarily in Section 4.4.

ALTERNATIVE 1

The impact the proposed facility may have on the ambient air quality is based upon an analysis of the expected air emissions and extrapolation of those air emissions for the surrounding environment through air dispersion modeling.

Emissions would occur as a result of mining, vehicle traffic, ore processing, loading and unloading, and diesel combustion (dryer, vehicles, etc.). The single largest emission category is particulates, including fibers. Particulate and fiber emissions are proposed to be controlled using a number of control technologies and work practices. To control road dust, the largest source of particulate emissions, the proposed plan calls for watering and the use of a chemical dust suppressant. The specific dust suppressant is not specified. The most common suppressants include magnesium chloride, lignon sulfate, and others. According to an EPA policy paper on fugitive dust emissions, these methods typically reduce potential emissions by 85 percent.

There are numerous potential sources of emissions from the concentrator. The air classifying system (winnowing), conveying, and crushing of the ore all create a potential for emissions. The method of control for these emissions is an air collection system followed by treatment in a fabric filter device

(baghouse). The baghouse is a system that passes air through a cloth-like filter such as polyester, polypropylene, Nomex, etc. The filter removes a large portion of the particulates in the air. The baghouse manufacturer states its system has a removal efficiency which equals or exceeds 99.9 percent. For purposes of analysis, however, a lower removal efficiency of only 99 percent was used. This provides a conservative estimate of emissions, especially if those emissions are smaller particles. The baghouse device is normally considered best available control technology (BACT).

Particulate emission figures were estimated primarily using EPA emission factor tables taking into account process quantities and control technology efficiencies. Table 4.2-1 summarizes the emission estimates from various categories, assuming the control systems and procedures specified in the mine plan are in place.

Table 4.2-1 shows that vehicular dust from the access road is the major component of PM10 emissions for this project, accounting for 91 percent of total particulate emissions. Particulate emissions from mining and conveying of ore to the concentrator are predicted to result in less than 8 tons/year (8 percent) of the total PM10 emissions related to operation of the mine at ABM Ridge. The concentrator will contribute a minimal amount of particulates to the environment (< 0.01%) due to the air pollution control equipment discussed above.

Emission estimates for the other pollutants were also estimated using EPA published emission factors for diesel combustion. The emissions include the concentrator and mine equipment (trucks, dozer, etc.). Table 4.2-2 provides a summary of the analysis.

Nitrogen oxides represent the largest single category of gaseous pollutants (approximately 80 tons/year or 73 percent of the total).

ESTIMATED IMPACT

An estimate of the impact that the emissions above may have on the ambient air quality of the surrounding region was made using dispersion modeling. The models chosen were Complex 1 and the Industrial Source Complex (ISC) short-term and long-term models. These models were chosen since they are compatible with the recommendations found in EPA (1987) guidelines. Details regarding the modeling, including meteorological data selection and related matters can be found in the Health Risk Assessment (Appendix A).

Table 4.2-3 provides a summary of the estimated impacts of the proposed project at various locations for particulate (PM10) emissions. Modeling scenarios include the mine and concentration facility, site, nearest residence, and Hamilton. Both models predict increases in particulate (PM10) concentrations in Hamilton which would be well within Federal and Montana ambient air standards (applicable standards). Highest PM10 concentrations would occur at the mine site. Predicted particulate concentrations from mine-related actions in Hamilton are extremely low. Background PM10 concentrations for either the mine site or Hamilton are not available for comparison.

Table 4.2-4 summarizes the predicted maximum concentrations of gaseous emissions from the mine and related activities. Again, both models predict increases in gaseous concentrations at the mine but the increases are minimal, except for nitrogen dioxide 1 hour peak concentrations. Predicted nitrogen dioxide maximum 1 hour peak concentrations are elevated, although still well within State and Federal ambient air standards. Predicted increases in gaseous pollutant concentrations in Hamilton from the project are minimal.

TABLE 4.2-1

ESTIMATED PM10 EMISSIONS SUMMARY
ALTERNATIVE 1
(TONS/YEAR)

Mining and Conveying	7.88
Concentrator	0.52
Loadout	0.14
Waste Rock Area	0.14
Vehicular Dust	90.00

TABLE 4.2-2

ESTIMATED POLLUTANT GAS EMISSIONS SUMMARY
ALTERNATIVE 1
(TONS/YEAR)

Sulfur Dioxide	5.32
Carbon Monoxide	17.39
Hydrocarbons (VOC)	6.41
Nitrogen Oxides	79.97

TABLE 4.2-3

MAXIMUM PREDICTED PARTICULATE (PM10) CONCENTRATIONS
AND APPLICABLE STANDARDS

	Complex 1 ($\mu g/m^3$)	ISC ($\mu g/m^3$)	Applicable Standard[a] ($\mu g/m^3$)
Peak 24-Hour Mean			
Mine Site	6.3	31.9	150
Hamilton	0.08	0.32	150
Annual Average			
Mine Site	0.91	3.31	50
Hamilton	0.0	0.04	50

[a] Administrative Rules of Montana, Emission Standards (16.8.1401 et seq.)

TABLE 4.2-4

MAXIMUM PREDICTED GASEOUS POLLUTANT CONCENTRATIONS
AND APPLICABLE STANDARDS

	Complex 1 ($\mu g/m^3$)	ISC ($\mu g/m^3$)	Applicable Standard[a] ($\mu g/m^3$)
Nitrogen Dioxide			
1-Hour Peak			
Mine Site	308.8	462.40	564
Hamilton	4.1	5.3	564
3-Month Mean			
Mine Site	8.9	5.6	94
Hamilton	0.0	0.0	94
Carbon Monoxide			
1-Hour Peak			
Mine Site	67.1	100.5	26,450
Hamilton	0.9	1.2	26,450
8-Hour Peak			
Mine Site	23.2	26.2	10,350
Hamilton	0.1	0.2	10,350

[a] Administrative Rules of Montana, Emission Standards (16.8.1401 et seq.)

The modeling analysis only included the emissions from the proposed activity. The results, therefore, represent the expected increase in air pollution as a result of the proposed activity only.

As part of the permitting process, Stansbury will be required to obtain an air quality permit. This permit will require an extensive air monitoring program designed to meet State and Federal ambient air requirements.

ALTERNATIVE 2

Ambient air quality impacts from the Western Vermiculite Project are minimal and within Federal and State standards. No additional mitigation measures are proposed.

ALTERNATIVE 3

Current ambient air quality levels would continue as they presently exist.

CUMULATIVE IMPACTS - None identified.

RESOURCE COMMITMENTS

During construction and operation of the mine, particulate and gaseous emissions would increase above current levels in the project area and nearby area. However, these increases would be within applicable air quality standards. Following the mine c con quality impacts from the project are negligible.

4.3 GEOLOGY AND MINERALS

Other than removal of the vermiculite resource, no adverse impacts to the geology of the project site are anticipated. Removal of the vermiculite is an irreversible commitment of the proposed action. It is reasonably foreseeable that exploration of the immediate and general vicinity will occur as mining progresses. It is also likely that the adjacent claims in Horse Ridge will be developed and mined if the a mining eration on ABM Ridge proves to be worthy of the investment. These actions would require a separate plan of operations from Stansbury and additional environmental analysis by BNF and DSL.

4.4 PUBLIC HEALTH RISKS

A Health Risk Assessment was performed to evaluate potential health risks from amphibole minerals present in the ABM Ridge ore deposit under Alternative 1. The results of the HRA indicate that health risk estimates are negligible (less one in a million excess cancer risks) for all exposure scenarios and conditions considered. Furthermore, because the assumptions used in this HRA were intentionally conservative or protective, it is likely that even those potential health risks are overestimated rather than underestimated. In particular, the assumption that nonasbestiform actinolite would cause the same adverse health effects as asbestos is an extremely conservative assumption. The conclusion of the HRA is that potential health risks from actinolite in the ABM Ridge ore deposit are extremely remote.

ALTERNATIVE 1

As part of this EIS, the potential health effects resulting from airborne amphibole fibers associated with Alternative 1 (Stansbury's proposal) are evaluated. This was accomplished by development of a Health Risk Assessment for the Western Vermiculite Mine project. A Health Risk Assessment (HRA) is a technical evaluation which characterizes the nature and extent of risks posed by sites, processes, or activities. The scope of HRA can vary in size and complexity, but a HRA typically includes information on the site type and amount of chemicals/minerals present, potential chemicals (in this case, minerals) of concern, evaluation of exposure pathways, and toxicity of chemicals (minerals) present. This information is then combined to characterize potential health risks for a specified area(s) of interest.

The HRA prepared for the Western Vermiculite Mine project follows the outline described above. The HRA was performed jointly by Dr. Kenny Crump, K.S. Crump-Clement Associates, and the University Risk Assessment Center — University of Cincinnati. These experts were selected to perform the HRA by the agencies, based on input from Camp Dresser & McKee and the public. These individuals were selected based on risk assessment expertise, knowledge of asbestos issues, and absence of any potential conflicts-of-interest.

The scope of the HRA is offsite exposure to amphibole fibers released by various mining-related activities. The minerals of potential concern at the site are the amphibole minerals actinolite and hornblende. The exposure pathway is release of amphibole fiber into the air, and the relevant route of exposure, or the way people can be exposed to these fibers, is inhalation. The relevant potential health risk is cancer. To characterize potential health risks from this project, potential excess cancer risk estimates are calculated for several exposure scenarios.

A summary of the potential Health Risk Assessment is presented here. Complete details of the risk assessment are contained in Appendix A. Potential health risks from amphibole fibers in water are discussed qualitatively in Section 4.5.

MINERALS OF CONCERN

The minerals of potential concern at the ABM Ridge ore deposit are amphibole minerals capable of forming fibers during handling and processing of the vermiculite ore. Five amphibole minerals have been identified in the ore deposit: anthophyllite, cummingtonite-grunerite, tremolite, actinolite, and hornblende. Of these, only actinolite and hornblende have been shown to produce fibers in this deposit. The form of these two amphibole minerals does not appear to be asbestos-like (USFS/DSL 1988). Nevertheless, the fibers from these minerals were evaluated as if they were, in fact, asbestos.

EXPOSURE ASSESSMENT

Exposure point concentrations, or concentrations predicted to occur at the various exposure locations, were developed in different ways depending on the type of information available. For the mine site and related exposure scenarios, estimation of potential air concentration of amphibole fibers is based on amphibole content of ore, predicted dust levels associated with various mine-related activities, and air dispersion models. For the exfoliation plant in Butte, air concentration of amphibole fibers is based on EPA guidance values for facilities like vermiculite furnaces, and air dispersion models. These estimation methods are discussed in detail in Appendix A.

The amount of amphibole fibers calculated to be released into the atmosphere in the vicinity of the mine from mine-related activities was then extrapolated to various locations away from the mine site using an air dispersion model and meteorological data from the site and the general area. The extrapolated concentrations of airborne amphibole fibers at various locations, such as the closest residence or the city of Hamilton, were used to estimate exposure amounts that could occur under selected exposure scenarios.

Several exposure scenarios were selected for evaluation. The exposure scenarios were selected to represent a range of exposure conditions, although they are not exhaustive. The exposure scenarios are distinguished primarily on the estimated amount of fibers in air, as well as the duration and frequency of exposure. In addition, the effect of when the exposure to fibers occurs was also evaluated. The following exposure scenarios were considered in this EIS:

- Hunting trips in the vicinity of the mine
- Residential exposure at the closest residence
- Residential exposure in Hamilton
- Exposure from a truck spill accident
- Residential exposure near the exfoliation plant

TOXICOLOGY ASSESSMENT OF ASBESTOS

There is virtually no information available regarding the potential health effects of hornblende or nonasbestos actinolite. For the purposes of this risk assessment, it is assumed that the health effects of these two amphibole minerals are identical to asbestos. Asbestos can cause asbestosis, a fibrotic lung disease which leads to gradual loss of lung capacity. Asbestosis is generally a result of massive and sustained exposure such as might occur in an asbestos mine or textile mill. Asbestos has also been shown to cause types of cancer, such as mesothelioma (cancer in the lining of the lung or abdominal cavity) and lung cancer. The airborne concentrations of asbestos thought to represent an increased risk of cancer are considerably lower than concentrations causing asbestosis. Since the exposure scenarios used in this risk assessment are residential and recreational, the concentrations of amphibole fibers are very much lower than those associated with asbestosis. Cancer risks are higher than asbestosis at lower fiber concentrations, so cancer was selected as the toxic endpoint to evaluate potential health risks.

To evaluate cancer risks, it is necessary to use a cancer potency factor to develop excess cancer risk estimates. The cancer potency factor is simply a value which is related to the ability of a given chemical or mineral to cause cancer in animals or humans. In the case of asbestos, several potency factors have been developed for both mesothelioma and lung cancer which are based on different datasets and assumptions regarding exposure levels and cancer mechanisms. These potency factors were reviewed to select the most appropriate factor for this risk assessment. The cancer potency factors for asbestos recommended by EPA were selected based on several reasons discussed more fully in Chapter 4.0 of the HRA (Appendix A).

HEALTH RISK CHARACTERIZATION

The final step in the risk assessment process is a combination of exposure estimates with cancer potency factors to derive potential upper bound cancer risk estimates for the selected exposure scenarios. Both lung cancer and mesothelioma risks were evaluated. The cancer potency factors selected for this EIS were those recommended by EPA. Due to the powerful synergistic effect of smoking and asbestos, potential excess cancer risks for smokers and nonsmokers were calculated separately. The results of these calculations are presented in Table 4.4-1.

TABLE 4.4-1

STANSBURY PROJECT ALTERNATIVE 1
ESTIMATED RISK OF CANCER FROM OFFSITE FIBER EXPOSURE
(PER MILLION PERSONS EXPOSED)

	Non-Smoker			Smoker		
Exposure Scenario	Lung Cancer	Mesothelioma	Total[a]	Lung Cancer	Mesothelioma	Total
20 years of continuous exposure in Hamilton beginning at birth	0.0003	0.012	0.012	0.003	0.009	0.012
20 years of continuous exposure in Hamilton beginning at age 20	0.0004	0.004	0.004	0.003	0.003	0.006
20 years of continuous exposure at the nearest residence beginning at birth	0.009	0.063	0.072	0.084	0.057	0.14
20 years of exposure - 3 days hunting/year	0.011	0.12	0.13	0.10	0.085	0.19
One-time exposure on hunting trip to 24 hour maximum levels	0.0003	0.006	0.006	0.003	0.004	0.008
Exposure 120 meters from truck spill accident	0.0002	0.007	0.008	0.002	0.006	0.008
20 years exposure at nearest residence to exfoliation plant	0.0005	0.018	0.019	0.005	0.014	0.019

[a] In some cases, total risk estimates differ from specific risks calculated individually for lung cancer and mesothelioma due to rounding.

An excess cancer risk estimate of one-in-a-million is typically used as a point of departure to evaluate potential health risks by many state and federal regulatory agencies. In other words, an added health risk of one cancer case per million persons exposed is considered to be a negligible or *de minimis* risk.

As indicated in Table 4.4-1, the maximum excess cancer risks calculated for any exposure scenarios considered in this EIS for the Western Vermiculite Project is 0.19 per million for a smoker who participates in twenty consecutive 3-day hunting trips annually for 20 years in the vicinity of the mine. (In other words, 2 persons in 10 million persons exposed). This is five times lower than the *de minimis* health risk level. The next highest risk estimate (0.14 per million) is associated with residential exposure for a smoker who lives nearest the mine and who is exposed to amphibole fiber emissions from the mine for 20 years beginning from birth. Maximum excess cancer risk estimates for Hamilton are 0.012 per million for a smoker exposed to amphibole fibers from birth. Risks from other exposure scenarios range from 0.13 per million to 0.0003 per million.

Based on the results of the Health Risk Assessment, the likelihood of adverse health effects from amphibole fiber exposure is extremely remote.

UNCERTAINTIES

A major uncertainty associated with the HRA is the assumption that exposure to the actinolite and hornblende minerals present in the ABM Ridge ore deposit would have the same potential to cause cancer as asbestos. There are very little experimental animal or human exposure data to support this assumption and it represents an extremely conservative, or protective, bias of the risk assessment results.

Another large component of uncertainty is the emission rates of amphibole fibers from mine-related activities. Emission rates had to be extrapolated from a combination of laboratory analyses, dust generation factors, and assumptions regarding mine operations. To compensate for these uncertainties, conservative assumptions were incorporated into the assessment in each step in the analysis to obtain a reasonable maximum exposure. The result of these multiple assumptions is that the Health Risk Assessment is more likely to overestimate, rather than underestimate, the potential health risks derived from the Western Vermiculite Project.

ALTERNATIVE 2

The health risk estimates associated with Alternative 1 are extremely small and the results of this very conservative risk analysis indicate that the probability of health effects is extremely remote. No specific modifications to Stansbury's mine operating plan are proposed; Alternative 2 is equivalent to Alternative 1.

ALTERNATIVE 3

Under the No Action alternative, the mine would not be developed. Amphibole release into air would occur slowly and only through natural weathering of the exposed ore body. The magnitude of the amphibole release would be undetectable and similar to what occurs under current conditions.

CUMULATIVE IMPACTS

No other activity on the BNF is expected to increase amphibole emissions. If simultaneous mining permits for other Stansbury claims in the area were granted, exposure estimates would be expected to increase for Alternative 1 and Alternative 2. However, the increased concentration of airborne amphibole emissions would be dependent on the intensity of mining activity and mine location.

RESOURCE COMMITTMENT

None identified.

4.5 HYDROLOGY

ALTERNATIVE 1

Surface Water Flow

The proposed mine would reduce evapotranspiration (loss of water from soil and plants), reduce infiltration, and increase runoff from the mine area as a result of vegetation removal and subsequent mining and mining-related activities (mine pit facilities area, HRWS area, haul roads, access road). The proposed operation may also physically alter and/or dewater the perennial streams and wetlands located on the east and west sides of ABM Ridge.

Increased annual water yields from runoff have been estimated as high as 4 inches per acre of disturbance according to the 1987 R1/R4SED Stream Sedimentation Model (USFS, 1981) run by the USFS. From this previous modeling effort, runoff from the mine area increased to 29 percent above baseline conditions on the mine disturbance area. The water yield increase from the mine, however, is expected to be practically immeasurable in the St. Clair Creek watershed due to the seasonal and spatial variations in precipitation and runoff events coupled with the small proportion of the drainage impacted by mining. Increase in average annual water yield from the disturbed areas would occur primarily during spring snowmelt runoff, with melt occurring a few days to a few weeks earlier on the disturbed areas.

Dewatering of ABM Ridge by mining may also affect the surface water system, particularly if the ground water, which is tributary to St. Clair Creek, is permanently abstracted and beneficially used for dust abatement. No data are available on predicted ground water inflow rates to the mine pit.

Continued monitoring of the USFS's upper St. Clair Creek monitoring station (Stansbury Monitoring Station WV-14) and Station WV-12, located above the mining activity, would not provide adequate documentation of potentially measurable changes in flow from the watershed during mining and after mine reclamation. Although changes in flow may fall within the natural flow regime of the baseline surface water system, additional monitoring stations and more frequent monitoring than three times per year are necessary to accurately quantify flow. The additional data allow a more accurate assessment of runoff and flow impacts from the mine.

Springs and Seeps

The flow from springs and seeps (see Figure 3.5-2, Surface Water Monitoring Locations) located within and proximate to the mine disturbance areas could potentially be affected by mine operations, particularly the springs on the east and west sides of ABM Ridge and the springs noted in the HRWS area. The wet

area in the HRWS area is also believed to be notably larger in August 1990 (6 seeps) than observed in 1987 (2 seeps). Due to the uncertainty as to how the shallow ground water system works in both the mine and HRWS areas, these springs and seeps require additional monitoring to verify accurate prediction of impacts to the hydrologic balance and reclamation success of the mine during and after operations.

Surface Water Quality

Results of chemical and physical analyses presented in the mine permit application (Stansbury Holdings Corporation, 1990a) indicate that the host rock is extremely stable and not easily weathered. Thus, the proposed vermiculite project is not expected to produce or leach any toxic metals or create acid water problems.

During core drilling, Stansbury noted sulfide mineralization in the area of the mine generally below the limits of project disturbance. In 17 of the 44 boreholes drilled on ABM Ridge, minor amounts of sulfide minerals were encountered near the bottom of the hole. Because sulfides were only encountered once within the vermiculite ore body itself, and beyond the limits of the proposed pit, the potential for sulfide-related impacts to occur, such as acid generation, are considered to be negligible.

Mining-associated infilling of a portion of the ABM Ridge tributaries in 1980 does not appear to have had any short or long-term impacts to overall water quality, except increased sedimentation along the upper reaches of the affected tributaries and possible short-lived increases in total suspended solids concentrations in the tributaries and the mainstem of St. Clair Creek during peak runoff events. Further discussion on sedimentation impacts is presented in the following section.

Evidence provided by a USFS/DSL sampling and analysis program (1988) indicates the presence of various amounts of amphibole minerals in the vermiculite ore body. Of these amphibole minerals, only actinolite and hornblende are capable of producing fibers after crushing and processing based on analytical tests performed by RJ Lee (1988a). Actinolite is capable of existing in two mineral forms, one of which is called actinolite asbestos. The form of actinolite present in the ABM Ridge ore deposit is a nonasbestos form (USFS/DSL 1988). Hornblende is reported not to exist as an asbestos form. Therefore, from a mineralogical standpoint, the ore body is not a source of asbestos-type mineral.

Both these amphibole minerals can form fibers. Analytical tests designed to detect asbestos routinely do not differentiate between asbestos and non-asbestos forms of these minerals. For regulatory purposes, then, water quality criteria for asbestos would apply to water concentrations of total amphibole minerals. A sample of St. Clair Creek water downstream from ABM Ridge was collected by the U.S. Forest Service in August, 1987, during low flow conditions. An asbestos concentration of 85,000 fibers per liter was found. This sample was a combined sediment and water sample that attempted to duplicate natural conditions during turbulent flow. The sample was not collected using standard EPA water sampling procedures and could not be considered for baseline analysis. Therefore, the finding of this sample is not directly comparable to any State or Federal standard.

Before Stansbury could discharge to state surface waters a MPDES (Montana Pollution Discharge Elimination System) permit would have to be obtained from the Montana Department of Health and Environmental Sciences. This permit would specify effluent limits and conditions based upon provisions of the Montana Water Quality Act, including the non-degradation rules. The "non-degradation standard" for this project would be based on background fiber levels in St. Clair Creek. Additional information on these levels must be collected before a permit could be issued.

There are both State and Federal water quality criteria for asbestos fibers which may apply to the Western Vermiculite Project, in addition to the non-degradation standards. The Montana Board of Health and Environmental Sciences (BHES) has adopted, by reference, the EPA's human health risk of one excess case of cancer per million people exposed. For asbestos, this corresponds to a level of 30,000 fibers/liter.

The actual effluent limitations which would apply to this project would be determined as a part of the MPDES permit process. DHES would consider ambient conditions, applicable State and Federal criteria designed to protect human health and other beneficial uses, best available control technologies and best management practices, when setting effluent limitations. A tentative MPDES permit would be based on the most restrictive standard and would then be subject to public review before final issuance by the DHES.

The impacts of the mine on amphibole fiber levels in St. Clair Creek and, subsequently Gird Creek and Bitterroot River, are considered to be negligible due to the fact that: 1) the bulk of amphibole minerals would be separately handled for disposal in the HRWS area and 2) surface water control measures such as diversion and sedimentation ponds would greatly retard the movement of mine sediments into St. Clair Creek.

Sedimentation

Sedimentation analyses for the Stansbury project involve determining whether or not:

- Stansbury's proposed surface water control plan is effective in controlling runoff and erosion from the project site,

- Potential sediment pond disharges would impact the flow and water quality in St. Clair Creek.

To evaluate these issues for the EIS, two separate analyses were performed using a computer modeling approach.

Approach

Determination of sedimentation rates requires integrating the multiple effects of soil and geologic features, hydrology, vegetation, slope, and other factors such as control practices. In mining areas, where surface disturbances tend to increase surface water runoff and sediment yields, a surface water control plan is designed to minimize sedimentation impacts. Under Alternative 1, Stansbury has proposed a drainage and sediment control plan to protect St. Clair Creek basin water quality from potential impacts. The control plan uses a combination of diversion structures, collection ditches, settling ponds, and revegetation to manage runoff from both disturbed and non-disturbed areas. Mine area surface water control systems such as those planned by Stansbury are designed to function under a range of rainfall-runoff events and conditions that may occur during the life of the mine. For this reason, it is important to evaluate the overall effectiveness of the surface water control system and to determine the specific sedimentation effects under selected conditions. A description of Stansbury's proposed water management and sediment control plan for the mine operation is summarized in Section 2.2. A more detailed description of the plan is presented in Stansbury's Plan of Operations. Stansbury has stated in their application that final engineering for the water management and sediment control plan would be reviewed with the agencies.

Two sedimentation models were considered for evaluating the potential effects of Stansbury's proposed operations: the U.S. Forest Service R1/R4SED Model and the SEDCAD+ model (Schwab and Warner, 1987). Although commonly used by the USFS to predict the sedimentation effects of timber harvests, road construction and fires, the RI/R4SED model cannot analyze specific storm-related rainfall/runoff events or the quantitative effects of surface water controls such as those proposed by Stansbury. SEDCAD+ was designed specifically for application to mine-disturbed watersheds, can analyze the effects of surface runoff controls, and thus was used to evaluate Stansbury's proposed operations.

Although the use of a modeling approach for this analysis provides the advantage of semi-quantitative over qualitative methods, there are also inherent limitations to its use. Care was taken to characterize, as accurately as possible with the available data, the hydrologic and sedimentologic conditions of Stansbury's proposed mine within the St. Clair Creek drainage basin. However, no storm-related field sediment monitoring data are available with which to calibrate the model. The model SEDCAD+ also tends to over-predict sediment yield and runoff, particularly for higher volume/discharge storm events. Therefore, readers should note that the results are likely to be more conservative (higher) than what would be observed under actual field conditions. Further, the lack of calibrating field data prevents the model's predicted flows and sediment yields from being verified and adjusted to observed conditions. The model's value to the EIS therefore is to identify gross, order-of-magnitude changes in the expected streamflows and sediment yields rather than a highly accurate quantitative measure of the absolute amount of change anticipated.

Sediment Pond Modeling

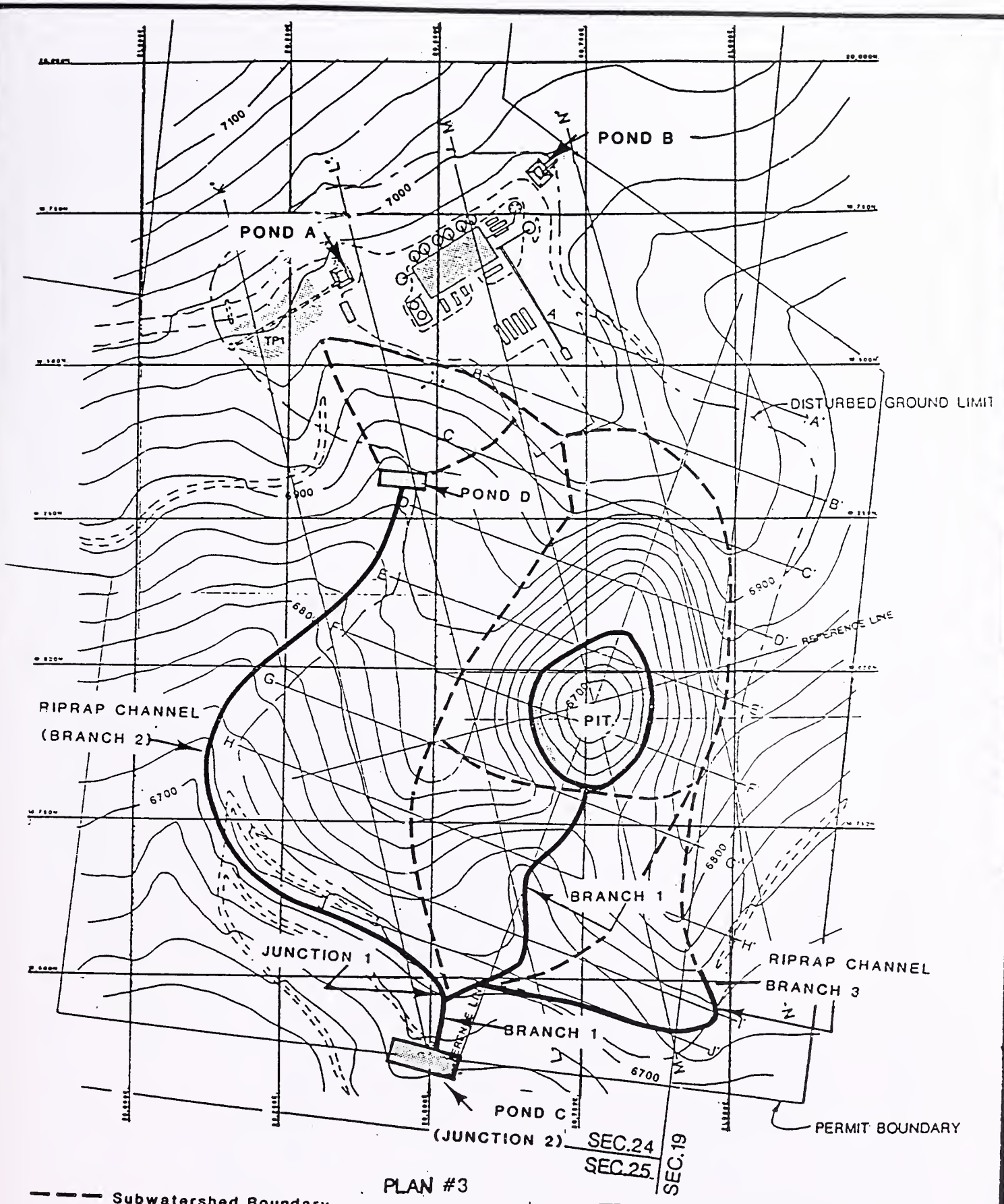
The SEDCAD+ model was run to evaluate the performance of Stansbury's proposed mine and HRWS area sediment ponds, including the mine pit. The mine area surface water control system includes sediment Ponds A, B, C, and D, and the mine pit, which are shown in Figure 4.5-1. Two additional stockpile Ponds, G and F, are shown in Figure 4.5-2. Ponds C and D, the mine pit, and stockpile Ponds G and F were evaluated for the 10-year, 24-hour storm which is standard regulatory requirement for mining projects of this size and duration. The drainage areas which contribute runoff to Ponds A and B are extremely small. They would not be likely to generate large amounts of sediment during runoff events and as a result were dismissed from the analysis.

To conduct the modeling, each watershed in the mine and stockpile areas was divided into smaller sub-watersheds. Each sub-watershed was then characterized according to its anticipated condition during the last year of proposed mining and related operations. This characterization includes evaluating those factors which influence runoff and sediment yield such as soil types, land use, slope, vegetation, and other attributes for each sub-watershed (Table 4.5-1). These data were then used by the model to predict the hydrologic response of each sub-watershed to a pre-defined rainfall-runoff event.

The sediment ponds and the mine pit were modeled using the final, last-year-of-mining contours and disturbance conditions which represent the available descriptive information from Stansbury for this analysis. Two scenarios were modeled under this overall mine area condition:

- Sediment ponds empty
- Sediment ponds at capacity

The first scenario represents a condition in which the proposed sediment ponds have their full capacity available to attenuate the effects of storm-related or other runoff. The second scenario represents the potential antecedent condition which may occur under some circumstances after the spring snowmelt.



PLAN #3

— — — Subwatershed Boundary

Note: Ponds and Pit not to scale

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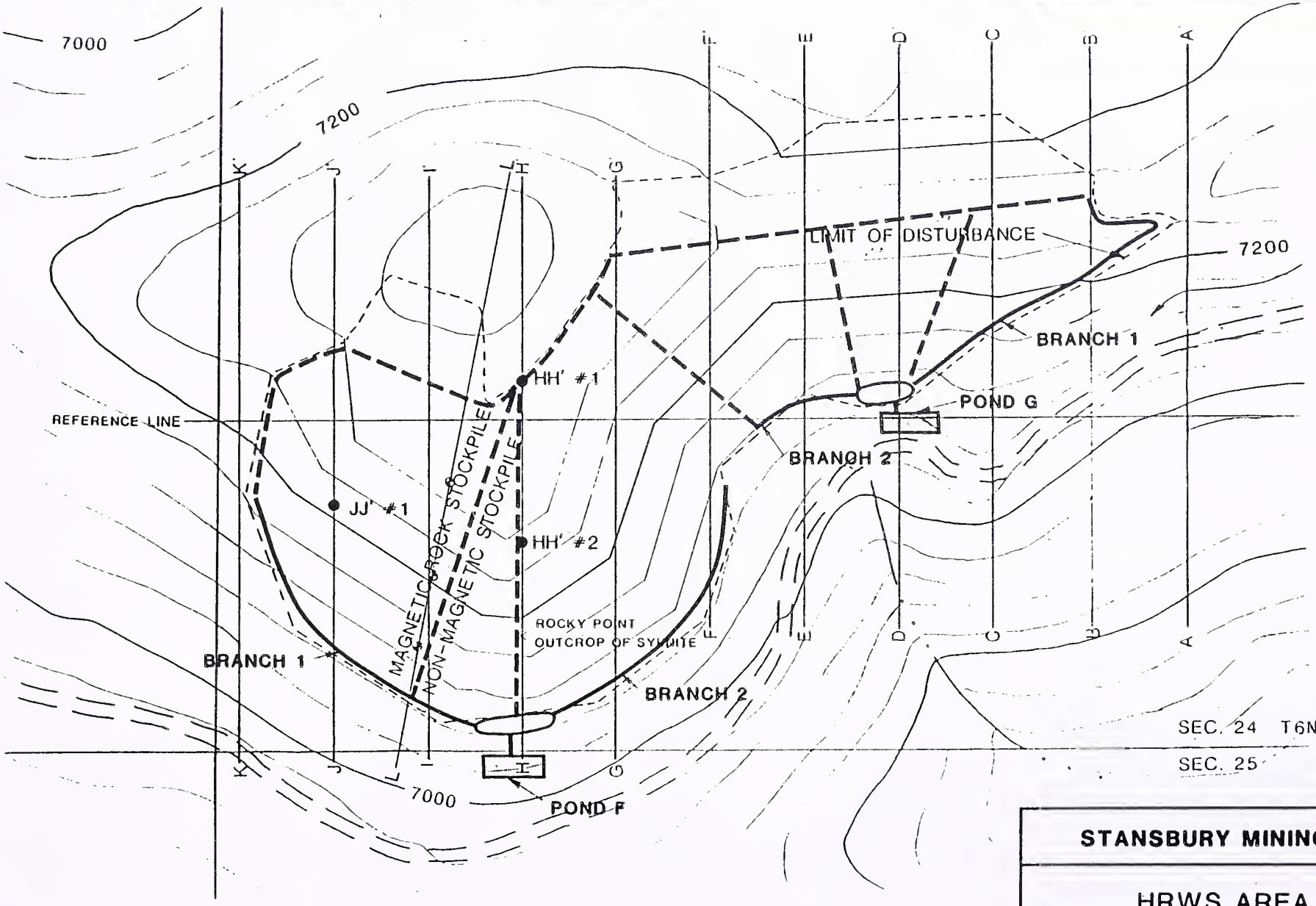
MINED AREA MODEL CONFIGURATION

CAMP DRESSER & McKEE INC.

CDM

FIGURE 4.5-1



ADAPTED FROM STANSBURY HOLDINGS, 1990a BASEMAP.

STANSBURY MINING EIS

HRWS AREA MODEL CONFIGURATION

CAMP DRESSER & McKEE INC.

CDM

environmental engineers, scientists, planners, & management consultants

FIGURE 4.5-2

TABLE 4.5-1

KEY SEDIMENT MODEL INPUT PARAMETERS

Land Condition	Curve Number by Hydrologic Soil Group			Control Practice Factor
	A	B	C	
Mine Area[1]	–	86	–	1.0
Host Rock Waste Stockpile Area				
Pond F[2]	–	61	–	0.013
Pond G[3]	–	61/86	–	0.013/1.0
Haul Road[4]	–	61/86	–	0.013/1.2
Forest[5]	32	58	72	0.001[6]
Roads[7]	50	69	79	0.04[8]
Clear Cut Areas[9]	35	56	70	0.003[10]
Existing Mine Disturbed Area[11]	–	65	–	0.2

Source: CDM, 1990.

1 Bare soil
2 Revegetated with 100 percent grass cover
3 Approximately 50 percent of drainage area revegetated/50 percent bare soil
4 Revegetated side slopes/compacted road
5 Woods grass combination, good condition
6 Effective canopy, 75-100 percent of area
7 Open space fair condition 50-70 percent grass cover
8 No canopy, 60 percent ground cover, idle land
9 Brush, weed, grass mix, fair condition
10 No canopy, 95-100 percent ground cover, idle land
11 Open space with 20 percent ground cover, poor condition

Under this second scenario, the ponds would not necessarily have their full capacity available, with resultant greater potential for discharge of water and sediment.

The modeling results for the "empty pond" scenario indicate that, with the exception of Pond C, the ponds would retain the 10-year, 24-hour runoff as planned. The model predicts that Pond C, however, would receive an inflow that would exceed its 0.1 ac-ft capacity by a factor of seven. The predicted peak discharge and peak sediment concentration from the pond would be on the order of 14.4 cfs and 3,163 mg/l, respectively. Based on the modeling results, it appears that discharge from the sediment pond could potentially impact the flow and water quality of St. Clair Creek under these conditions. Sediment pond discharge to surface waters requires a Montana Pollution Discharge Elimination System (MPDES) permit from the Water Quality Bureau of MDHES. Actual discharge effluent limitations would be determined based on information provided by Stansbury in the MPDES permit application. Stansbury has not yet applied to MDHES for an MPDES permit.

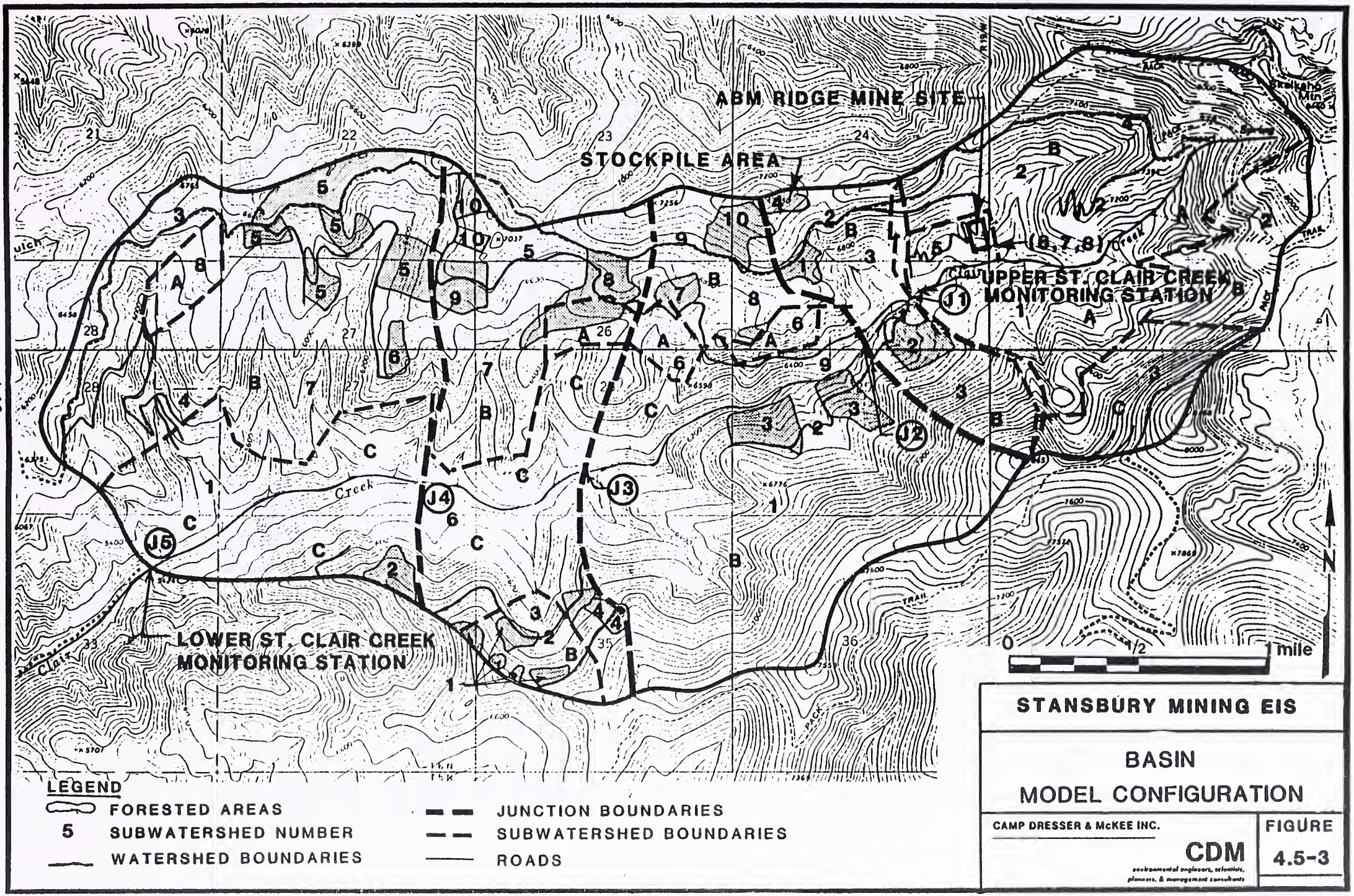
The second scenario evaluated was one in which all of the mine area sediment control ponds were assumed to be full. In considering this possibility, it is important to note that the ponds do not become non-functional when filled to design capacity. Rather, they are designed to continue functioning at a high level of sedimentation efficiency, but do have the potential to release runoff that exceeds their volumetric capacity along with some given concentration of suspended sediment. This scenario represents a positive mine operation water balance which may occur during the spring snowmelt period when runoff is high and the potential mine operation consumptive needs (i.e., for road dust suppression) are comparatively low. These conditions, combined with potential discharge to the ponds from mine pit dewatering, could for a limited time keep all of the ponds full at their design capacities. Under this scenario, there would be no excess pond capacity to accommodate precipitation runoff, and logically the model indicates that discharges would occur from all the sediment ponds during the 10-year, 24-hour storm event.

Stansbury has also stated they would clean ponds in the fall and early spring to maximize efficiency and help alleviate discharge problems.

Basin Modeling

To estimate potential sediment impacts from the proposed mine operation on St. Clair Creek flow and water quality, the "full-pond" modeling scenario, as described above, was incorporated into a larger basin model (see Figure 4.5-3). The model was then used to evaluate effects at the upper and lower monitoring stations on St. Clair Creek for the 2-, 10-, and 25-year, 24-hour storm events.

Flow results of the Alternative 1 full-pond scenario basin sediment modeling (Table 4.5-2) were compared to those of baseline, existing conditions (Table 4.5-3). Under Alternative 1 peak flows increase for each storm event modeled at both upper and lower St. Clair Creek. In contrast , sediment modeling results indicate that under Alternative 1, peak total suspended solids (TSS) concentrations increase in upper St. Clair Creek for the 2-year, 24-hour storm while decreasing for the 10- and 25-year, 24-hour storm. In lower St. Clair Creek, peak TSS concentrations increase for both the 2- and 10-year, 24-hour storms while decreasing for the 25-year, 24-hour storm. The conclusion from the basin modeling results is that for most storm events, Stansbury's proposed mine with sediment control structures in place would reduce sediment yield to St. Clair Creek relative to current sediment yields from the existing mine disturbance area.



STANSBURY MINING EIS

BASIN MODEL CONFIGURATION

CAMP DRESSER & McKEE INC.

CDM

environmental engineers, scientists, planners, & management consultants

FIGURE 4.5-3

TABLE 4.5-2

RESULTS OF ALTERNATIVE 1 FULL-POND SCENARIO
ST. CLAIR CREEK BASIN SEDIMENT MODELING

Storm Event	PPT (inches)	Upper St. Clair Creek Station		Lower St. Clair Creek Station	
		Peak Discharge (cfs)	TSS (mg/L)	Peak Discharge (cfs)	TSS (mg/L)
2 yr 24 hr	1.5	13.9	1,625	63.7	313
10 yr 24 hr	2.1	20.6	2,736	124.7	399
25 yr 24 hr	2.5	38.9	2,438	188.8	439

Source: CDM, 1990.

[1] Precipitation values from USDC 1973.

TABLE 4.5-3

RESULTS OF BASELINE ST. CLAIR CREEK BASIN SEDIMENT MODELING

Storm Event	PPT[1] (inches)	Upper St. Clair Creek Station		Lower St. Clair Creek Station	
		Peak Discharge (cfs)	TSS (mg/L)	Peak Discharge (cfs)	TSS (mg/L)
2 yr 24 hr	1.5	5.5	31	49.4	129
10 yr 24 hr	2.1	15.9	3,533	103.0	377
25 yr 24 hr	2.5	32.1	7,900	162.5	498

Source: CDM, 1990.

[1] Precipitation values from USDC 1973.

Ground Water Availability, Levels, and Flow

Mine Area

Stansbury's permit application states that a plan for dealing with ground water inflow to the pit, if encountered, must be devised and meet with DSL and USFS approval. The plan would use best appropriate technology taking into consideration inflow water quality, quantity, location of the pit, and other pertinent characteristics of the situation. Methods available to deal with the inflow include grout sealing, settling, use for dust control, and discharge. The selected remedy would meet MDHES, DSL, and USFS criteria for minimizing effects.

Recently collected borehole water level data indicate that ground water would be encountered during the mining operation. No information is yet available to estimate the rate of flow into the mine pit. In addition, no information is available to predict what potential impacts to the perennial drainages supporting wetlands to the east and west of ABM Ridge might occur as a result of mine pit dewatering. Potential effects to flow at Springs 1 and 2 located to the east of ABM Ridge need also be considered. Given these uncertainties, it would be necessary for Stansbury to provide a plan which specifies technologies to be used for minimizing ground water inflows, determining how the water would be handled, used and/or disposed, and minimizing impacts to the local hydrologic regime.

Host Rock Waste Stockpile Area (HRWS)

Seeps were noted in the HRWS area during both the 1987 and 1990 spring surveys. Discharge from the seeps generally totaled less than 1 gpm. For those seeps which are encountered in areas of the HRWS area, roadways or fill, Stansbury would propose a control plan to the USFS and DSL for approval. Stansbury would obtain approval from the agencies regarding the selected method for controlling the seeps prior to initiation of any construction.

Because of the potential for saturation of fill material in the HRWS area due to the pressure of the previously noted small seeps, a series of piezometers would be installed to monitor the phreatic surface in the HRWS area. Three piezometers would be located in the HRWS area to provide an adequate measure of ground water conditions in the HRWS. These piezometers would be monitored monthly for water levels and data would be sent to the agencies.

Review of the data would indicate if saturation is a potential problem. If a problem is identified, the agencies would be notified and action would be taken to reduce infiltration. Other measures would be considered as the situation warrants. Piezometers would be installed as stockpiling progresses.

Ground Water Quality

Due to the lack of toxic or leachable minerals within the host and waste rock, the potential for impact to ground water quality due to mining-related operations is considered to be negligible. If at any time in the future conditions change and a potential impact is evident, Stansbury would need to obtain a Ground Water Pollution Control Permit from the MDHES.

ALTERNATIVE 2

Surface Water Flow

Increased monitoring would be performed prior to and during mining operations and for a period of time after mining to monitor the effects of reclamation.

Monthly same-day flow monitoring prior to, during, and after mining operations at Stations MV-10, 11, 12, and 13 would also be performed to assess potential impacts to flows, particularly in the drainages located to the east and west sides of ABM Ridge which could potentially be dewatered by mining. Flow monitoring would, at a minimum, include measurements taken beginning with spring runoff through late fall.

Springs and Seeps

Springs and seeps should be monitored for flow on a monthly basis to establish premining conditions against which potential mining impacts can be assessed. Sampling could be modified dependent on results. In addition, for those springs located in and adjacent to both the HRWS area and mine area which are, or could potentially be, dewatered and/or modified, detailed observations of flow and geologic source (where possible) should be made on a periodic basis (particularly during excavations and physical alterations). These data would provide insight to the hydraulics of the ground water system on-site and help to determine future mitigative measures to control, modify, or restore flow where necessary.

Surface Water Quality and Sedimentation

Coincident with the monthly flow monitoring at stations MV-10, 11, 12, and 13, water quality samples would be collected for total suspended solids and fiber analysis. Monthly water quality sampling would also be conducted at the upper St. Clair Creek USFS station. Total suspended solids samples would also be collected bi-weekly during the rising and falling limits of the spring snowmelt runoff hydrograph.

Storm sampling would be conducted during thunderstorm events, and include instantaneous flow measurements, plus collection of samples to be analyzed for TSS and asbestos. Suspended sediment sampling and Forest Service bedload sampling data would be reviewed to determine if any measurable impacts of mining are evident. If impacts are evident, additional measures would be taken by the agencies to abate the increased sediment yield and to protect aquatic habitat and downstream fisheries (see Aquatics, Section 4.6).

No SEDCAD+ modeling was conducted to evaluate Alternative 2 mitigations.

An inwardly draining mine pit would receive surface water runoff from a nine-acre drainage area, and potential ground water inflow. The pit volume (30 ac-ft) is large enough to accommodate these flows without discharging during the life of the mine. This would reduce sedimentation yields to St. Clair Creek, but to what extent is uncertain.

When Stansbury applies for a MPDES permit, the Water Quality Bureau would determine the adequacy of the surface water control plan in meeting State standards.

Ground Water Availability, Levels, and Flow

Because ground water would be encountered within the mine pit area, Alternative 2 would include a plan to obtain or provide the following:

1) Baseline seasonal ground water levels, gradient, and flow direction to include measurement of water levels monthly, as the site is accessible.

2) Mine pit inflow measurements for flow and quality during the mining operations.

3) Disposal of pit water in a regulatory-approved manner (e.g., land application) if pit water quality is not acceptable due to fiber levels,.

4) Institution of mining and reclamation practices, where practical, to protect the hydrologic balance of the wetlands.

5) Monitoring program for water levels in the mined land reclamation area to estimate reclamation success and wetlands preservation and/or regeneration.

6) Reanalysis of water rights issues if ground water wells are used for beneficial project uses and pump over 100 gpm.

7) Routine monitoring of St. Clair Creek as described for surface water flow and quality to determine the effectiveness of the mine's sediment control regimen. Surface water discharge permits (MPDES) for the settling ponds would also include mitigative sediment control stipulations, such as maximum allowable concentration of total suspended solids in the discharge and maintenance protocols.

ALTERNATIVE 3

If the proposed mining activity does not occur, the disturbed areas at the existing mine site would be reclaimed. Reclamation would reduce runoff and sediment loading to St. Clair Creek, and the hydrologic balance of the drainage basin would approximate near pre-mining levels. Because no reclamation plan for the existing mine-disturbed areas has yet been designed, Alternative 3 was not modeled. However, it can be expected that upon reclamation, suspended sediment concentrations and peak flows in both upper and lower St. Clair Creek would be less than those predicted for existing conditions (Table 4.5-3).

CUMULATIVE IMPACTS

Cumulative impacts to the hydrologic balance of the St. Clair Creek drainage basin primarily include the expansion of vermiculite mining to other portions of the basin, particularly Horse Ridge located immediately east of ABM Ridge. No new timber harvests within the St. Clair Creek basin above the U.S. Forest Service's lower St. Clair Creek monitoring station have been proposed for the next ten years. Potential future mining and mining-related activities such as mine pit and HRWS areas, haul roads, and concentrator facilities could possibly contribute additional impacts to the surface and ground water system of the basin, particularly with respect to potential increased sediment yields affecting suspended solids and amphibole fiber concentrations in St. Clair Creek. However, all plans for future mining would be evaluated by Federal and State agencies at the time of mine permit application submittal.

RESOURCE COMMITMENTS

If the proposed mine operation is implemented, approximately 30,000 gpd of water (or 16.6 ac-ft/yr for a 180 day/year operation) would be permanently withdrawn from the surface/ground water system for beneficial consumptive use. This consumptive use would only occur during the life-of-mine, or five to eight years for this permit amendment.

4.6 AQUATIC LIFE

GENERAL IMPACTS

Primary and secondary impacts to aquatic organisms in the St. Clair Creek watershed could occur during the construction and operation of the project mine. Primary impacts to aquatic organisms that could occur during construction and operation of the mine include stream habitat degradation as a result of increased sedimentation and increases in runoff and erosion as roads and mine facilities are built and expanded. Secondary aquatic life impacts could result from project-related growth, such as the addition of point and non-point pollution sources, and increases in fishing pressure and in recreational and consumptive uses of regional water resources.

Sedimentation loadings from the mine site and the proposed haul roads to St. Clair Creek were modeled by both CDM using the SEDCAD+ model (Schwab and Warner, 1987) and the U.S. Forest Service using the R1R4SED sedimentation model (USFS, 1981). Both models generated results showing potential increased sedimentation delivery yields. However, modeling analyses alone cannot determine the effects that would occur to the fishery resources in St. Clair Creek. The sedimentation models were not field-validated. In addition, there are other factors, such as species sensitivity to sediment, fish distribution patterns, and habitat quality, which need to be considered to evaluate aquatic impacts (Swanson, 1990). Therefore, the results from these models should not be used to determine precisely any impacts that could occur to the fishery resources. Instead, these models should be used to provide a relative comparison of impacts for each alternative.

A potential also exists for toxic materials to enter St. Clair Creek through accidental spills from truck accidents and leaks from storage tanks. Diesel fuel, oil, and gasoline can be toxic to aquatic life. For the Western Vermiculite Mine project, the probability of an accidental spill cannot be quantified, but is probably low.

ALTERNATIVE 1

Potential impacts to the fisheries and other aquatic life in St. Clair Creek from the proposed mine operation are primarily related to increases in sedimentation and changes in water quality and quantity. The proposed mine plan would institute erosion control measures, such as berms and sedimentation ponds. If these measures are effective in controlling runoff and erosion from the mine site, impacts to aquatic life would probably be minimal. Under the full-pond scenario (which over predicts flow and sediment yield; see page 4-14), there could be resultant increases in sediment quantities being transported to and deposited in St. Clair Creek, changes in channel configurations, and filling in of interstitial gravel over time. Stream habitat could potentially be affected by siltation of spawning gravel, premature siltation of natural pools, and reductions in productivity and available food sources, primarily the macroinvertebrate community.

SEDCAD+ sedimentation modeling results for Alternative 1 presented in Table 4.5-2 tentatively show that peak total suspended solids (TSS) concentrations from the 2, 10, and 25 year 24 hour storm events would range from 313 to 2,736 mg/L. These concentrations are generally above the levels considered protective of trout, as shown in Table 4.6-1. The sediment concentrations may adversely affect aquatic macroinvertebrate populations in St. Clair Creek, but the degree of impact is difficult to quantify. No adverse impact on fish near the mine site itself is likely because electroshocking data (USFS, 1990a; MDFWP, 1978) for the upper reach of this drainage show no fish in the area.

The fishery in the lower reach of St. Clair Creek could be affected during certain storm events based on results from the SEDCAD+ modeling. However, under average non-storm related conditions, no adverse impact to the fishery resource is anticipated as the sedimentation ponds and control structures should adequately manage runoff and erosion from the mine site.

Preliminary modeling by the U.S. Forest Service using the R1R4SED model also demonstrated potential impacts to the fishery resources in St. Clair Creek (Hammer, 1990). As previously mentioned in Section 4.5, the R1R4SED model is designed to predict average annual, cumulative sediment effects from timber harvests, road construction, and fire. Although the model is not designed to quantitatively evaluate the effectiveness of designed mine sediment control structures, it is possible to input to the model sediment pond trap efficiencies at drainage points. An 85 percent trap efficiency was assumed. An eight year life-of-mine, which included two years of post-mining reclamation, was also assumed. The sequencing of mine operations, waste disposal, and reclamation activities during mining were integrated in the model to conform as closely as possible to Stansbury's mine plan.

The estimated adjusted threshold value considered to be protective of fish for St. Clair Creek was determined by the U.S. Forest Service to be a 79 percent increase in average annual sediment yield over baseline conditions. Preliminary R1R4SED modeling results indicate that for each year of a projected six year life-of-mine, the fish threshold value is exceeded by as much as 40 percent (i.e., 119 percent increase over baseline conditions). For the two years subsequent to mining, during which the site is reclaimed, the average annual, cumulative increase in sediment yield drops to 40 percent, well below the fish threshold value of 79 percent.

These preliminary values can be considered as an overestimation of sediment yield because SEDCAD+ modeling results indicate that the efficiencies of Stansbury's sediment ponds is generally above 90 percent compared to the 85 percent assumed in the R1R4SED model. Thus, R1R4SED model results for average annual, cumulative sediment yields due to mining would likely be less if a higher sediment trap efficiency were used. Nevertheless, both the R1R4SED and SEDCAD+ model results indicate that mining would cause increases in sediment yield to St. Clair Creek under some scenarios. Currently, the stream sediment monitoring program is not sufficient to adequately establish baseline conditions. Thus, under Alternative 1 it is not presently possible to quantitatively assess potential impact to the fishery resources.

ALTERNATIVE 2

Sediment loading to St. Clair Creek from the mine site would be monitored by expanding the monitoring program detailed under Alternative 1 of Section 4.5, Hydrology. If results from the monitoring program indicate that the erosion control measures are not adequate in protecting St. Clair Creek aquatic resources, then additional mitigation measures, such as increasing the size of the sedimentation ponds to accommodate the runoff, would be considered. Discussion of the MPDES permit for discharge to State surface waters is given under Surface Water Quality in Section 4.5, Hydrology.

TABLE 4.6-1

TOTAL SUSPENDED SEDIMENT CONCENTRATIONS
CONSIDERED PROTECTIVE OF TROUT

Level of Protection	Maximum TSS Concentration (mg/L)
High level of protection	25
Moderate level of protection	80
Low level of protection	400
Very low level of protection	over 400

Source: Committee on Water Quality and the European Inland. Fisheries Advisory Committee (Sorenson et al. 1977).

ALTERNATIVE 3

Sedimentation modeling results for baseline existing conditions show that unacceptable sediment loadings which are not protective of the fishing resource in St. Clair Creek may occur during specific conditions and storm events of varying frequency and duration. It is expected that upon mine site reclamation under this alternative, sediment yield will be reduced, providing greater protection to the aquatic resources.

CUMULATIVE IMPACTS

Through the proper implementation of best management practices from timber harvest, mining, and any additional road development, cumulative impacts of additional sediment loading and nutrient concentrations would be minimal. Failure of on-site control measures, and/or additional sediment loading from any potential logging within the same drainage could further degrade the already stressed aquatic community in the upper reaches of St. Clair Creek.

RESOURCE COMMITMENTS

Increases in sediment loading from all future activities could potentially reduce the diversity and productivity of the aquatic biomass in all reaches of St. Clair Creek.

4.7 WILDLIFE

ALTERNATIVE 1

Wildlife - Elk and Mule Deer

Development and operation of the Western Vermiculite mine would have direct and indirect impacts to local wildlife resources. The wildlife species that would receive the most impact from the mining operations are the big game mammals. Elk, and to a lesser extent mule deer, would be displaced to some degree by the mining operations and activities associated with access to the mine site and the HRWS. However, it is anticipated that these disturbance activities would have a minor impact on elk and deer populations in the project area, since much of the activity associated with mining of the vermiculite would occur on the presently disturbed site and during the time when elk are on summer range. Some expansion at this site is planned to accommodate the concentrating facilities. The HRWS would be located on a ridge 0.75 mile west of the mine site. Vegetation at this site was clear-cut in 1986, but less than 10 acres additional surrounding forest vegetation would have to be cleared to accommodate the HRWS and 3 additional acres for the haul road. This expansion could reduce forest cover, but the expected acreage lost would have a minimal impact on the elk population.

About 100 acres of forest habitat immediately surrounding the mine and the haul road would probably receive less use by big game due to human activity at the site. Another 100 acres of open rangelands at the lower elevations of the access road would also receive limited use by big game as a result of increased vehicular use.

The greatest effect on the elk population would come from the sporadic activities that would be associated with the mining operation. The operating plan for the mine proposes a 24-hour work environment, which includes two or three work shifts. The cumulative noise and human activity associated with the operation of the mine, and the increase in vehicular traffic during a 24-hour period, could affect big game distribution and utilization of the surrounding habitat.

Characteristically, the quantity and quality of winter range and the distribution of cover and forage controls the size, dynamics, distribution, and productivity of the elk population. The distance these big game species, primarily elk, would be displaced from the access road is not precisely known. However, Ward (1976, 1985) suggests that this could be up to a 0.25 mile. Should this occur, additional pressure would be placed upon the Bitterroot Game Range and the surrounding national forest to accommodate a larger population. Impacts of increased vehicular traffic and human activity in elk calving areas during the spring have an even greater potential for affecting calving success and could result in an unquantifiable reduction of elk calves joining the population annually.

Disturbance to elk on winter range could occur if mining operations continue past October 15. This situation could be magnified during periods of mild winters which would allow for a longer period of operation. The continuation of vehicular traffic during these periods could create additional stress on the animals that utilize that portion of the Bitterroot Stock Farm near the proposed haul road for winter range. As these animals are displaced into other areas, there would be more competition for the already limited supply of forage and cover on the Stock Farm.

The construction of the operating facilities at the mine site would minimally impact the elk population if the construction took place when elk were on summer range. Habitat disturbance as a result of new construction at the existing mine site would have little impact on the elk. The animals displaced by activities associated with the mining would move to other summer ranges with minimal effect to the elk herd. The elimination of the two wet meadows in the permit area could reduce available forage for elk that use the St. Clair Creek corridor during migration. These transitional habitats are very important, because it is the condition in which the elk enters winter and its condition immediately before calving that affect winter mortality and calf survival (Taber et al., 1982).

Other Wildlife

Wildlife species other than big game would be minimally affected by the construction and operation of the mine. Many of the small animal species, especially the grouse, could be more vulnerable to increased hunting and trapping with an increase in human activity in the area. Additionally, increases in vehicular animal collisions would occur as a result of increased vehicular traffic in the project area.

Habitat disturbed by the mining operations and construction of the HRWS would have only negligible effects to the avian fauna in the project area. Potential perching and nesting sites in dead trees might be lost to tree clearing. Those species which are dependent upon cleared areas for foraging and cover would temporarily be displaced.

Threatened or Endangered Species

The bald eagle and the peregrine falcon are not likely to be affected by the proposed mining operations and related activities because neither species have been observed in project areas.

ALTERNATIVE 2

A road closure program to control vehicular access to the ABM Ridge and surrounding area during hunting season, calving, and migration periods would enhance the area for elk. About one mile of roads that could be closed to improve elk security include: Road 364 past the junction of the mine roads in the NW1/4 of Section 25, and the road past Skalkaho Mountain 714 to 62622. In addition, scheduling of mining operations to avoid increased activity in the project area during migration and hunting season

would reduce the cumulative impacts that threaten elk security. Scheduling the operation of the mine between May 15 and October 15 would reduce the impact to elk on the winter range, and reducing activity along the haul road between May 15 and June 15 would be beneficial to the elk as they move up the migration corridor to summer range. Vehicular activity during the mining operations would be reduced by bussing workers to and from the mine site.

ALTERNATIVE 3

Existing human activity (hunting, etc.) would continue. Disturbance of wildlife habitat and wildlife displacement under the proposed No Action alternative would not occur. For 2 years under reclamation, human activity would increase, but afterwards would be reduced and habitat improved.

CUMULATIVE IMPACTS

Mine site disturbances in conjunction with the loss of habitat to logging sales in the area would put further demand on the remaining stands of timber as cover for animal species. Elk move from their summer range on the Skalkaho Game Preserve to winter range on the Bitterroot Game Range via the Willow Creek/St. Clair Creek ridge (personal communication, John Ormiston, 1990). Timber operations in the Willow Creek drainage could displace more elk to the St. Clair Creek drainage as a result.

Cumulative impacts, more so than direct, would moderately impact big game in the project area for two to four years. Elk and deer are found throughout the project area, and could be minimally affected by increases in hunting pressure and recreational road use. Elk security would be particularly affected during hunting season by increased human activity, increased vehicular traffic associated with the mining operations, and the proposed Calf Creek Timber Sale (USFS, 1990b). The Gird Creek Timber Sale is too far away to affect the elk herd associated with ABM Ridge (USFS, 1990c).

The redesignation of the Skalkaho Game Preserve to a Wilderness Area could place additional stress on the elk populations near the mine site. Currently, hunting is not allowed in the Game Preserve. However, hunting is permitted in most Wilderness Areas. Should this redesignation occur, additional road closures may be necessary to reduce pressure on the elk population.

The sale of the Bitterroot Stock Farm, and the development plans by the new owner (conservation vs. subdivisions) could determine what impacts will occur to elk populations that use winter range on the Stock Farm. Any loss in winter range as a result of development on the Stock Farm will place more demand on the Bitterroot Game Range and the surrounding National Forest to meet habitat requirements for elk.

RESOURCE COMMITMENTS

Habitat disturbance and wildlife displacement would temporarily increase pressure for food and cover in surrounding areas as wildlife migrate away from the mine site. Species with greater mobility, such as elk and deer, may utilize the area to some extent concurrent with mining operations, but most smaller animals would be completely displaced during operations due to lack of habitat. All species would return to the site after reclamation. There are no irreversible or irretrievable resource commitments.

4.8 SOILS

ALTERNATIVE 1

Soils from the pit and concentrator area, the HRWS, and miscellaneous disturbances associated with roads would be disrupted and mixed during the process of salvage, storage, and redistribution. As a result of this disruption, these soils would lose some structure and tilth, and varying fractions of their biological components, including roots, seeds, and other parts of higher plants, as well as soil microflora and fauna. During the process of salvage, storage, and redistribution, a small amount of soil would be lost to erosion. The mine plan calls for storage of salvaged soil in the concentrator area and placement of sediment Pond D in the wetland immediately west and south of the existing mine. Loss of this wetland reduces local habitat diversity.

These consequences would persist for the short to medium term, relieved as biological activity in the revegetated areas allows reestablishment of soil mineral cycling, organic matter decomposition, and redevelopment of soil structure.

ALTERNATIVE 2

Consequences relating to soils resources would be similar to those for Alternative 1, except that relocation of topsoil storage out of the wetland west of the mine area relieves that negative consequence.

ALTERNATIVE 3

Under this alternative, the area previously disturbed by mining would be reclaimed under a DSL reclamation bond.

CUMULATIVE IMPACTS

The increasing pressure from multiple use objectives would cause soil erosion if other potential surface disturbances (notably logging and road building) occurred simultaneously below the mine site. Implementation of best management practices would keep the overall soil loss to a minimum. The mining operation is likely a minor component of overall soil loss in Management Area 1.

RESOURCE COMMITMENTS

Some soil loss would occur due to the clearing of vegetation and transportation to stockpile sites. Prolonged stockpiling of topsoil would result in some degradation of soil quality due to conditions within the piles. Following redistribution across the site, the soil viability would eventually return to previous levels.

4.9 VEGETATION

ALTERNATIVE 1

The vegetation of the pit, concentrator, and HRWS would be destroyed during the mining operations. Wildlife habitat and the productive capacity represented by these plants would be diminished. Since green plants fix carbon dioxide and liberate oxygen, the loss of green plants represents a temporary decrease in carbon dioxide fixation until such time as vegetation is restored to the disturbed areas. Since much

of the mine pit and concentrator area has previously been disturbed and not revegetated, the additional loss of productive capacity from this area is very small. Furthermore, upon topsoiling and revegetation, there would be more vegetation cover on these areas than presently exists.

The proposed action may result in the direct and indirect loss of as much as 10 acres of wetland, a relatively scarce component of landscapes of the region. Alternative 1 would not result in adverse consequences to listed or candidate threatened or endangered plants, although *Linanthus nuttallii* (Nuttall's linanthus), a plant of limited distribution in Montana, and formerly listed as "RARE" by the Montana Rare Plant Project (Lesica et al., 1984), occurs in the area designated for water storage. The wetland area immediately east of the existing mine disturbance was found to have a high plant species diversity by USFS botanists examining the site in August 1990; in particular, two bog orchid species (*Habenaria dilatata* and *Habenaria saccata*) were observed there. As mentioned, wetland habitats are relatively scarce occurrences in western landscapes and, as in this case, often are small islands of increased plant diversity.

The proposed action would disturb a small stand of western needlegrass (*Stipa occidentalis*) grassland in the HRWS area (Shelly, 1990). This is a negative consequence because good examples of native grassland are uncommon within this mostly forested region.

Disturbances associated with the proposed action, primarily those of widening the access road, would increase the sites on which spotted knapweed could invade. This noxious weed is widespread in the Bitterroot Valley. Disturbances along the access road could immediately increase the abundance of spotted knapweed. At the higher elevations of the mine site, chances of invasion by knapweed are small. In all cases, prompt revegetation which is proposed by Stansbury would minimize the potential spread of spotted knapweed and other noxious weeds. Canada thistle, another noxious weed, could likewise invade lower elevation disturbed sites along the access road, but its invasion of higher elevation disturbed sites would likely be limited.

ALTERNATIVE 2

Consequences would be similar to Alternative 1, except that wetland vegetation loss would be reduced. Direct loss of wetland would be eliminated in Alternative 2 by 1) relocation of topsoil storage out of the wetland west of the mine site; 2) relocation or deletion of sediment Pond D, which currently is located in the wetland west of the mine site and compensating enlargement of sediment Pond C if necessary; 3) rerouting of the interceptor ditches at the edges of mining disturbance above wetlands to avoid direct impacts and indirect dewatering; 4) relocation of sediment Pond B outside of the wetland northeast of the mine site; and 5) relocation of mine buildings and other facilities to avoid all wetlands.

The above modifications to the proposed action would avoid direct impacts to wetlands. Should the mining excavations indirectly harm wetlands by draining/dewatering, Stansbury, the USFS, and DSL would develop on-site procedures for re-establishment of wetlands of equal size following mining and/or develop offsite plans for creation of equivalent wetlands to compensate the loss of the wetlands on the ABM site. Wetland replacement would not completely compensate for the loss of the particular wetlands in question because they are wetlands of high plant diversity, an attribute not replaceable in man-made wetlands, at least in the short term.

The proposed action would possibly disturb a small stand of western needlegrass (*Stipa occidentalis*) grassland in the HRWS area according to the USFS August 1990 field survey (Shelly, 1990). This

disturbance would be avoided by confining the HRWS and associated road downhill to the area previously clear-cut.

ALTERNATIVE 3

Under this alternative, existing vegetation would remain in place to provide wildlife habitat, fix carbon dioxide, and liberate oxygen. The existing mining disturbance, where little vegetation exists, would continue to have very little vegetational cover until it is reclaimed. Reclamation would occur under DSL and BNF supervision pursuant to provisions of the existing bonded mining permit.

No Action would avoid the small additional presence of the noxious weeds spotted knapweed and Canada thistle that could result from access road widening at lower elevations.

CUMULATIVE IMPACTS

Disturbed areas will be reclaimed to areas of grass and trees. The maturation of planted trees would eventually develop a mature stand of timber. The Western Vermiculite Project would not further endanger the rare Sapphire Rockcress since: 1) it exists only at elevations well below the mine, and 2) the proposed haul route through this critical lower elevation is already in place (assuming road widening avoids the existing population). This temporary loss of vegetation cover and later replacement is part of a similar process (yet much smaller in magnitude) that occurs during logging throughout the forest.

RESOURCE COMMITMENTS

Some riparian habitat (less than 10 acres) could be irretrievably lost with the filling and/or dewatering of wetlands adjacent to the mine under Alternative 1. Direct impacts to wetlands would be totally avoided under Alternative 2. The total vegetated area would be greater following the project, as current areas of surface ore outcrops would be mined, replaced with redistributed topsoil, and revegetated. Existing bare areas from historic mining operations would likewise be revegetated.

4.10 VISUAL RESOURCES

ALTERNATIVE 1

The visual resources impacts of project activities under Alternative 1 are expected to be negligible to minor in magnitude. A major viewpoints analysis (in which locations which overview the site are mapped) of the ABM Ridge permit area and HRWS permit area was not performed in the field. However, a review of existing topographic maps and a brief line of sight analysis suggests that the only locations from which the mine and concentrator and HRWS area would be plainly visible would be from the peak of Skalkaho Mountain and along the ridge, pack trail road, and to the south towards Gird Point. The area to the north of Skalkaho Mountain, in the Fool Hen Lake vicinity, appears to be out of the line of sight of these project facilities.

The visibility of project facilities from South Hamilton, Grantsdale, and Charles Heights in the Bitterroot Valley to the south of Hamilton have been mapped at a distance of 12-15 miles. On a clear day, one can also look to the east and see the Horse Ridge area immediately above the mine and concentrator site. If one were to climb the valley side west of Hamilton and the Bitterroot River, the visibility of these areas would become more and more apparent, yet they would also be further distant. By line of sight, one is looking approximately 12 miles due east from Hamilton to view the mine and concentrator. From the

west side of the Bitterroot Valley, as one climbed the slopes to view the mine area, another 2-4 miles would be added to the visual distance.

From the areas immediately to the east and above the mine and concentrator site in the Skalkaho Mountain vicinity, an interruption of the continuous vegetative cover and pattern would be apparent as one viewed the mine and concentrator site. No visual simulations have been superimposed on the landscape for purpose of this analysis, but a review of the Exhibit II-2 in the permit application (Stansbury Holdings Corporation, 1990a) suggests that the cleared bench area with the concentrator, open pit mine, and related facilities would show visual impacts to viewers immediately to the east and above the site. It does not appear, however, that one could view the mine and concentrator site from the Gird Point location to the south, or from Palisade Mountain or various other peaks to the north and east. Therefore, impacts are most likely to be noticeable by hikers, horsepackers, hunters and fishermen in the upper reaches of the St. Clair Creek drainage and along the ridge traversed by FS 714. Any visual impacts introduced by this activity would be mitigated by the gradual terrain, darker-colored soils, distance viewed (12-15 miles from the valley), and the numerous natural opening/timber interfaces near the site.

As noted in the baseline section, the visual management objective for this site is "M," indicating that modification can occur and that introduced activities may appear dominant on the scene given the seldom-seen nature of the site. Though these introduced activities, such as the mine, concentrator, and HRWS, would not be compatible with the existing landscape, the required revegetation activities and the structure color treatment which would occur under the mining and reclamation permit would enable visual objectives to be satisfied after reclamation is accomplished.

ALTERNATIVE 2

The various mitigation measures proposed for Alternative 2 would not affect the visual impact of the mine area or HRWS site. The impacts would be the same as those for Alternative 1.

ALTERNATIVE 3

Under the No Action alternative, the existing disturbance from historic mining activities would be reclaimed under BNF and DSL supervision. Visual impacts from Hamilton are currently negligible. After reclamation, the mine site would likely be indistinguishable from the surrounding landscape.

CUMULATIVE IMPACTS

Some cumulative visual impacts in the project vicinity at present and in the future will occur from clear-cut forestry practices. These clear-cuts currently exist to the west and south of the site, and are visible from various points along the access road to the site. These clear-cut areas, in combination with the mine/concentrator/HRWS complex, are not significant in terms of the amount of acreage affected over the total project area. Clear-cut areas will also be reclaimed with cultivation and seeding, as well as through natural processes. Neither the proposed mine site nor clear-cut areas are located on primary travel routes. Therefore, the cumulative visual impacts of this mining and processing activity combined with forest clear-cutting practices do not appear to be large for the project area.

RESOURCE COMMITMENTS

Although the proposed mine site is visible from a few locations - Skalkaho Peak, ABM Ridge, FS364, and the upper St. Clair Creek drainage - these represent viewpoints of minimal usage. Thus, visual impacts would impact only the few who use the area for recreation. Proposed reclamation would largely decrease, and in many cases, eliminate the impacts.

4.11 RECREATION

ALTERNATIVE 1

The primary recreational use of this area is hunting. The environmental assessment of timber sales in the St. Clair Creek drainage (USFS, 1980) calculated that heavy use of the area for hunting was occurring, with over 300 recreational days/per season being experienced for purposes of hunting. Seven other recreational activities received a moderate rating (30 to 300 visitor days/per season). These activities included snowmobiling, hiking, horse use, nature study, auto and motorcycle use, and gathering forest products. The permit application also noted that in the late 1970s and early 1980s, Western Vermiculite's mining operations did displace the elk herd in the project area. However, current information suggests that elk have re-established themselves to some extent in this area, based upon personal reconnaissance and observations by USFS personnel. Impacts of the mining concentrating and HRWS operation are expected to be minor on hunting activity, which constitutes the primary recreational use of the project area. Project activities would cause only minor disturbance to other recreational users, who would most likely avoid this area should they want an outdoor experience with little influence of man's activities present. (See the Wildlife Affected Environment and Environmental Consequences sections for more detail on this issue).

ALTERNATIVE 2

Road closures are proposed as a wildlife mitigation. These road closures (about one mile) would limit recreational access to the project from the Gird Point vicinity to the south and perhaps from the Skalkaho Pass area to the east except for foot traffic. The bussing of workers to the mine area would limit noise, road dust, and greatly reduce user conflicts with recreational traffic. Other water quality, water supply, and wetlands mitigation measures would serve to help preserve the area in its natural state, thereby improving the recreational experience.

ALTERNATIVE 3

The No Action alternative would continue to allow the limited recreational use of the area with fairly active use for hunting in the fall, primarily north of the mine in the Willow Creek drainage. No impacts to recreational users in the vicinity of the mine site would be experienced as a result of increased noise, dust, or a visual interruption of the landscape.

CUMULATIVE IMPACTS

The addition of the proposed mine and facilities would have relatively little effect on the dominant recreational uses. Hunting would continue to occur near current levels. There is a potential for recreational user conflicts on the roads in the vicinity of the mine site. Recreational users seeking solitude and wilderness in this area would be displaced and would likely go to other more remote locations of nearby National Forests.

RESOURCE COMMITMENTS

The quality of the overall recreational experience may be slightly impacted. Of those affected, hunters may feel the impacts most, due to potential changes in the migrational patterns of the elk population during the life of the mine.

4.12 TRANSPORTATION

ALTERNATIVE 1

Transportation impacts of the proposal are expected to be minor to major. Stansbury Holdings Corporation (1990a) has estimated that 15 trucks per day for a period of approximately 6 months would haul concentrate to the exfoliation plant in Butte, and would use the proposed route shown on the map in Figure 3.12-1. Vehicle conflicts on this road (about 10 vehicles/day) with recreational traffic and other private use are currently believed to be minor. These conflicts are minimized by exclusive control of the road by a private party immediately west of the Forest boundary. USFS and Stansbury personnel currently access this area via locked gates. Presumably, these gates would remain open throughout the day and night to accommodate Stansbury personnel during operations, with warning signs limiting access to authorized personnel past certain locations on the road. A few vehicle conflicts with recreational or other private users may therefore occur daily as full operations are initiated, but these should not increase substantially over the current condition.

Additional conflicts on the Hamilton Heights road with project vehicle traffic are also expected to occur. Stansbury Holdings Corporation (1990a) has estimated that traffic on the East Side Highway (2,000 vehicles/day) would increase about 2.6 percent during operations. Traffic increases on the Hamilton Heights road would be even greater in terms of percentage, since it has less current traffic. Traffic on U.S. Highway 93 (9,000 vehicles/day) to Missoula would increase minimally, since this road currently receives extensive use.

Regarding employee traffic, with 60 employees and no bussing in place, it is assumed that some persons would carpool. It is estimated that approximately 40 vehicles would traverse the route daily (5 delivery vehicles, 15 ore trucks per day, and 20 employee vehicles). This traffic would have a moderate impact on the East Side Highway and Hamilton Heights Road and a major impact on the private and Forest Service access road to the mine site.

The section of Forest Service road from the mine to the private boundary is a low standard, single lane, dirt road which would require reconstruction for use by haul trucks. Stansbury has committed to maintain the road in a safe and adequate condition during operations, but has not specified a schedule or precise measures to upgrade the road. A single lane, partially-graveled road leads from the BNF boundary through private property to Hamilton Heights Road. This road is identified as a medium to low standard road. Hamilton Heights Road is a double lane, paved highway in fair condition. Use by heavy ore trucks would require increased maintenance.

The bridge on the Hamilton Heights road is substandard for heavy truck traffic and needs improvement. Ravalli County Highway Department officials intend to upgrade the bridge in the near future. The other highways into Missoula and Butte apparently present no further problems. Therefore, overall impacts to the existing transportation network are expected to range from minor to moderate as the result of project activities. It is noted that adequate shoulders for disabled vehicles do not presently exist on the

Forest Service road, the private road from the BNF boundary, or the Hamilton Heights Road. Stansbury is currently negotiating maintenance costs with the County.

Dust generated by truck use of partially graveled roads may require further evaluation and mitigation commitments. Stansbury has committed to water up to 20 miles of road, including both the mine/concentrator and waste dump areas, as needed. Whether the projected 30,000 gallons per day of water would be adequate to maintain proper dust control during dry, dusty summer periods is a matter of concern regarding impact analysis, since generated dust has potential safety, health, visibility, and aesthetic impacts. It is assumed for purposes of this impact discussion that adequate water would be provided, and that road use would therefore only have minor impacts in terms of dust generated.

ALTERNATIVE 2

Agency mitigation measures to address wildlife impacts would also ameliorate transportation impacts for the Western Vermiculite Project. Specifically, the bussing of workers would eliminate 20 to 30 vehicles per day. These buses would minimize impacts to the existing access road. Even with their heavier loads, busses would likely have less impact than 20-40 cars or pickup trucks. Also, it is expected that dust control would be easier with fewer worker vehicles on the access road. Road maintenance and improvements to be monitored by Stansbury would be specified, in order that safety problems from disabled vehicles, dust generation, and other impacts, can be properly mitigated.

ALTERNATIVE 3

The No Action alternative would leave in place the existing road situation, with intermittent use by Forest Service personnel on the low standard road on Forest lands, and minor use of the private road. The current road network is probably adequate for current uses, although as one enters the northeastern part of the urban area of Hamilton, other road improvement issues have arisen. Ravalli County Highway Department officials agree that the bridge on the Hamilton Heights road is substandard for heavy truck traffic and needs improvement. Current intermittent use of the Forest road and private road by Forest Service personnel and recreational users is adequately handled by existing road conditions.

CUMULATIVE IMPACTS

Cumulative impacts are unlikely on the access road because logging traffic related to the Calf Creek Timber Sale would go down Willow Creek Road. Minor cumulative effects are expected on the East Side Highway.

RESOURCE COMMITMENTS

Stansbury proposes to use 30,000 gallons of water per day to suppress dust on sections of haul route which are dirt or gravel. Over the project life, total usage for dust suppression could amount to 198.8 acre-feet of untreated spring water which would be irretrievable. Increased costs of road improvement and maintenance related to the Western Vermiculite Project represent a permanent resource commitment.

4.13 SOCIOECONOMICS AND LAND USE

SOCIOECONOMICS

ALTERNATIVE 1

Employment

A maximum of 60 operations employees (mining, concentrating, and trucking) would be working at the project site, or hauling materials to and from the site over the project life. All but seven operations workers would be employed full time for six months of the year.

Table 4.13-1 summarizes numbers of construction and operations personnel during a nominal project life of five to eight years. The construction employment is estimated to average 24 workers during the initial and only six-month construction period, as shown on Table 4-13-1. Approximately five construction personnel are expected to carry over into the second year to complete activities. Concerning operations personnel, it is estimated that the two current operations personnel would continue to oversee construction activities. During the second year, a rapid buildup of employees, working over the six month period each year, is projected. Stansbury Holdings Corporation (1990a) estimates that a maximum of 60 employees for the mine, concentrator, and trucking would be involved. About 25 skilled and unskilled workers would work at the concentrator during its operating schedule (two 12-hour or three 8-hour shifts are possible). About 7 employees would be employed full-time by Western Vermiculite in professional positions. Mining and waste hauling employment would involve about 20 persons. Finally, contract hauling of concentrates to the Butte exfoliation plant would involve an additional 8 truckers.

After the five to eight year project life is completed, it is estimated that about 10 persons would be involved to complete reclamation operations over a two year period.

In order to determine (a) the percentage of employees to be derived from the local versus non-local labor pool; (b) the number of indirect employees (restaurant workers, insurance salespersons, hardware store operators and similar induced occupations) that would result from the project; and (c) the number of in-migrants and their families (those moving into project vicinity to work at the mine and concentrator site), a recent EIS for a larger mining project near Libby, Montana was reviewed (DSL/USFS, 1990). This draft EIS, for the Montanore Project proposed by Noranda Corporation presents an extensive socioeconomic impact section for a project employing up to 190 construction workers and 450 operations workers. Several assumptions in the Montanore EIS have been adopted and modified, as shown below, for purposes of this EIS regarding: (a) percentage of local versus non-local workers; (b) number of indirect employment opportunities for each construction or operations job; (c) proportion of employees who are married; and (d) family size per in-migrating construction, operations, or secondary worker. Those parameters are as follows:

- Construction workers
  - 45 percent local
  - 55 percent non-local

- Operations workers
  - 80 percent local
  - 20 percent non-local

TABLE 4.13-1

ESTIMATED EMPLOYMENT AND POPULATION IMPACTS
STANSBURY WESTERN VERMICULITE PROJECT

Project Year	1	2	3	4	5	6	7	8	9	10
Employment (# of Persons)										
Construction	24	5	0							
Operations	2	60[1]	60	60	60	60	60	60		
Post-Operations/ Reclamation									10	10
Local Employment - Direct	11	48	48	48	48	48	48	48	10	10
Local Employment - Indirect	3[2]	11[2]	11	11	11	11	11	11	3	3
In-Migrants (# of Persons)										
Construction Employees	13	0								
Operations Employees	0	12	12	12	12	12	12	12		
Indirect Employees	1[2]	1[2]	1[2]	1[2]	1[2]	1[2]	1[2]	1[2]		
Spouses and Children for Above Employees	18	30	30	30	30	30	30	30		
+++Total In-Migrants+++	32	43	43	43	43	43	43	43		
Population										
% Increase from Project to Ravalli County Population	0.2	0.2[3]	0.2	0.2	0.2	0.2	0.2	0.2		

[1] Average employment for 6 month construction or operations period during year indicated.
[2] Indirect employment less than expected due to short construction period (5-6 months) prior to startup.
[3] Preliminary 1990 census data (24,909 persons) available only - no accurate projections per University of Montana (1990).

- Indirect employment created by each construction job
  - 0.3 workers (reduced to 0.17 for this project)

- Indirect employment created by each new mining job
  - 0.45 workers (reduced to 0.20 for this project)

- In-migrating employees
  - 60 percent of construction and indirect employees are married (average family size 2.1 persons)
  - 80 percent of operations workers are married (average family size 3.1 persons)

The following major reasons for reduction of these multipliers are:

1. Stansbury Holdings Corporation (1990a) has stated that local indirect employment during construction would be minimized because of the brief, 6 month construction season. Therefore, local indirect employment has been reduced from eight persons to three during the construction period.

2. The number of indirect jobs filled by local residents was reduced to 11 during the operations period, and the number filled by in-migrants reduce to 1, given the estimate that 90 percent of indirect operations employees are usually hired from the existing local labor force.

3. Multipliers were reduced because local indirect revenue and indirect employment is expected to be less for Stansbury than for other recent mining projects in Montana, due to the smaller size, relatively lower salaries, and six-month annual operations period.

4. Much larger base population and more support facilities in the Hamilton, Montana area.

The in-migrants portion of the table shows the number of construction and operations employees who would migrate to Ravalli County or likely commute from the Missoula area to work at the mine. Numbers are also given for spouses and children given the multipliers shown above for the Noranda project. It follows that total in-migrants, and, therefore, total increases to county population during construction and operations, would range between 32 and 43 persons for the life of the project. This analysis indicates that the project would cause a negligible 0.2 percent increase in the population of Ravalli County. Therefore, the employment and population impacts would have a very minor but positive effect on employment opportunities, employment income, and indirect tax revenues to the county (see Income section below). The project would also serve to diversify the economic base in the county.

Employment Income

Direct income from the proposed action includes compensation to the mine's employees and taxes paid to Ravalli County by the mining company. Estimates from Stansbury Holdings Corporation (1990a) indicate an average annual salary per employee of $8,846 for the six-month period. Stansbury expects the project to employ an average of 24 people during the construction phase (see Table 4.13-2).

The initial construction phase would cause mostly direct income effects. Salaries amounting to a total of $106,889 would be paid to employees, 45 percent of whom would be drawn from the local labor pool. Thus, those Ravalli County residents employed during the construction phase of the project would earn a total of $48,100 for the one-year operations phase.

TABLE 4.13-2
EMPLOYMENT DURING CONSTRUCTION BY MONTH

	MONTH					
	1	2	3	4	5	6
Employees	20	35	50	20	10	10
Total Income	$14,743	$25,801	$36,858	$14,743	$7,372	$7,372

Source: Adapted from Stansbury Holdings Corporation (1990a).

TABLE 4.13-3
PREDICTED ANNUAL TAX REVENUES

Resource Indemnity Tax (RIT)	$5,954
Non-Renewable Natural Resources Property Tax (annual net proceeds x county mill levy)	60,000
Micaceous Mineral Mines License Tax	1,500
Corporate License	101,250
County Property Tax	164,367
State Property Tax	4,000
ESTIMATED ANNUAL TOTAL	$337,071

Source: Adapted from Stansbury Holdings Corporation (1990a).

Once the mine is at full operation, it is expected that Stansbury will employ a maximum of 60 people. Salaries amounting to a total of $459,992 annually would be paid to employees. Since general mining operations may require less specialized skills, it is assumed that 80 percent of these employees would be drawn from the local labor pool, resulting in a total income to these Ravalli residents of $367,993 annually.

Indirect income effects include indirect employment, material purchases by the mine, mine personnel expenditures, and expectations of future economic expansion in Ravalli County. Employment not directly associated with the mining project (which nonetheless results from economic expansion related to the mine) is considered indirect employment. Increased employment, caused by mine operations, may be offset by the addition of mine employees' spouses to the local labor force. Of the materials purchased by Stansbury, only a small part are expected to be purchased from local suppliers (Stansbury Holdings Corporation, 1990a). An estimate of the effects of mine and personnel expenditures may be derived from the use of an income multiplier. In accordance with Stansbury's estimate, a multiplier of 1.4 was used to determine the derivative effects of these expenditures. In addition to mine salaries, another $416,093 annually would be earned in wages by Ravalli County residents in retail or other trades, and $582,531 annually would be injected into the local economy, stimulating expansion (Marshall, 1987). As is often the case, expectations in the community of an expanding economy would likely fuel further economic growth.

Taxation Income

Taxes associated with the proposed action would generate revenues for the State of Montana and Ravalli County. Taxes applicable to this mining operation include a Resource Indemnity Tax (RIT), Micaceous Mineral Mines License Tax, Corporate License Tax, Non-Renewable Natural Resources Property Tax, and State and County Property taxes. Details regarding each tax and fund are discussed further in the permit application (Stansbury Holdings Corporation, 1990a). Table 4.13-3 summarizes expected revenues to each fund from this project. Distribution of these funds is discussed further below.

Income generated from RIT would have no impacts on the State or local economy, since it is locked into a trust fund for the environmental protection of future generations.

Income generated from the Micaceous Minerals Mines License Tax would have a minimal effect on the State's economy, since it would contribute little into the State General Fund.

Due to its size, Corporate License and Income Tax (64 percent of which is also earmarked for the State's General Fund) would have a more significant impact on the State's revenues. Each year, the tax would contribute $101,247 to the State's General Fund, the School Foundation Program, and the Long Range Building Program.

County Property Tax from the mine, 32 percent of which would accrue to the County's General Fund and 68 percent to schools, would impact Ravalli County by increasing its tax base. Using the same income multiplier as above, it can be estimated that an additional $230,113 would be injected into the local economy.

Local Fiscal Impacts

Generally, the proposed action would have positive fiscal impacts on Ravalli County. Although additional services may be necessary to support the project, the increased tax revenues and employment would compensate the county for these services (Allen, 1990). Stansbury's assertion that local fiscal impacts of the project would be largely beneficial (1990a) appears valid. Service needs appear to be relatively low (primarily road and bridge improvements, utilities, and some local services) while taxes and employment each would show a notable but not overwhelming increase.

Fiscal impacts to the City of Hamilton are less definite. The city is in good financial health, with adequate surplus cash reserves to support its major program needs (Williamson, 1990). Fiscal benefits from the mining project and minerals taxes are not felt directly by the city, except regarding increases in local spending (no local tax is imposed). A general improvement to the local economy is expected from this project.

Real Estate Values

A mixed effect on real estate values will likely be experienced from mine development. Along Hamilton Heights Road (see Transportation) real estate values may decrease due to noise, dust, and safety concerns. Elsewhere in the county, increased demand for housing by project in-migrants may slightly increase land structure values.

Housing

For the 32 to 43 persons (or 10 to 14 new families) who would migrate to the county, housing may be difficult to obtain. Construction workers typically are transient, working in an area for 1 to 5 years while construction of a major project is completed and then move on to another. Therefore, they are often satisfied with mobile homes or rental properties which may not be as substantial as those demanded by semi-permanent residents, who hope to reside in the area for five years or more. Given the high real estate values in the county (see Section 3.14), and given that these semi-permanent residents (operations employees) would earn an average of about $8,846 for the six month period every year, it may be difficult for them to obtain and afford desirable, permanent single-family housing. Therefore, it is expected that a slight increase in the number of mobile home park spaces, increase in the sales of mobile homes themselves, and construction of lower income homes may occur in the county. On the other hand, these 10 to 13 families may be fairly easily absorbed as other properties which lie vacant are put up for rent, or as attrition moves other persons from the county.

Services

Again, because of the insubstantial number of new in-migrants to the county as a result of the project, the impacts on county services are expected to be minimal. It is estimated that the impacts to county's infrastructure — schools, medical care, police/fire/emergency services, utilities for solid waste management, water, and sewer — and the general ability of local planning staff to accommodate the small number of in-migrants would not create a difficult situation in local communities and rural areas. Therefore, impacts to county services are expected to be minor and are expected to be capably handled by the existing infrastructure. County planners and other offices will again likely use this EIS to plan for potential service impacts.

Social Structure

Discussion of existing social groups, their apparent values, and expectations for their future was presented in Section 3.14. An analysis of impacts to social structure from the mine operation, based upon the small number of in-migrants and their families, does not raise substantial concerns. Opinions have been expressed, especially by retired persons, that the mine workers and their families would create additional congestion on the roads (especially at the intersection of Hamilton Heights Road and East Side Highway), overcrowding, noise, air quality impacts, and generally disrupt the quality of life in Hamilton. From this EIS analysis, moderate to major adverse impacts of this type are not expected to occur. However, it appears that the mine's activities would generally add to the county's economy, improving and diversifying its economic base, while not substantially disrupting life in Hamilton and the surrounding communities. Some long-term effects of the project may include an overall increase in population and infrastructure beyond the project life. Impacts from this project are generally far removed from areas where persons live or would experience any adverse effects.

ALTERNATIVE 2

No specific mitigation measures for socioeconomic impacts are proposed because the impacts appear to be either positive or minimally adverse. Mitigations for other impacts, such as noise, dust, and traffic safety, would minimize nuisance impacts along the haul road as discussed in the Transportation impacts section (4.12) and Noise impacts section (4.15).

ALTERNATIVE 3

Without the proposed Western Vermiculite Project, Ravalli County would not realize the economic benefits that would likely accompany this mining project. All income described under Alternative 1 would therefore be foregone; i.e., the lost opportunity cost of the No Action alternative is equal to the direct and indirect income that the proposed action would generate. Conditions in Ravalli County would continue as described in the baseline section. Perceived adverse effects by some groups from increased population, crowding, noise, and haul trucks would not be experienced.

CUMULATIVE IMPACTS

No cumulative impacts were identified.

RESOURCE COMMITMENTS

The majority of socioeconomic resource commitments, including increased employment, income, services, and decreased supply of housing, are neither irreversible nor irretrievable. All would normalize upon project completion. Some long-term effects of the project may include a negligible increase in population and infrastructure beyond the project site.

4.14 CULTURAL RESOURCES

ALTERNATIVE 1

The Western Vermiculite Project, as proposed by Stansbury, would have no effect on significant cultural resources. Site 24RA244 (a collapsed adit with an associated cabin, spring house, and outhouse) would be impacted by the proposed development of the spring to supply water to the mining operation. This

site, in consultation with the Montana State Historic Preservation Office (SHPO), has been determined ineligible for the National Register of Historic Places (NRHP).

The access road down Charleys Gulch is within several hundred feet of site 24RA243 (possible religious site). The site would not be affected by any noise, vibration, or airborne dust impacts from the haul trucks. It is unlikely that truck drivers or other mine employees would encounter this site. In addition, the present landowner is aware of the location of the site and is concerned about protecting it from disturbance.

ALTERNATIVE 2

The Western Vermiculite Project would cause negligible potential adverse impacts to cultural resources. Bussing of workers to the mine site would tend to lessen the possibility of individuals in their cars stopping along the road for various purposes, and reduce the likelihood for disturbance to sites.

ALTERNATIVE 3

The No Action alternative would leave existing cultural resources in place, and the effects on the historic log cabin and mine adit would not be experienced. However, since these resources are not determined to be eligible to the NRHP, no impact difference to cultural resources of significance is expected should the No Action alternative be selected.

CUMULATIVE IMPACTS

The proposed project would have no significant cumulative impacts. None of the affected sites are eligible for the NRHP.

RESOURCE COMMITMENTS

No significant cultural resources are likely to be irretrievably or irreversibly affected by this proposal.

4.15 NOISE

ALTERNATIVE 1

The open pit mining and air winnowing process used to concentrate the vermiculite ore would have noise impacts similar to that of a sand and gravel operation. Fans, a diesel generator, loading and disposal of host rock waste to the stockpile, and other activities would presumably have noise impacts in the 80 to 100 dBA range (see the baseline discussion). These impacts would likely be experienced in the immediate project vicinity from 0.5 to 1 mile from which they occur, but absorption of noise by vegetation, soil, rock, and relief (hills and valleys) in the project vicinity would likely prevent noise from carrying much further.

Recreational hikers, hunters, and motor vehicle users (autos, snowmobiles, motorcycles) would likely experience noise impacts in limited instances.

Hunters in the same St. Clair Creek drainage who have hiked up from the base of the road or have paid for access through the private logging lands to the west may experience some noise impacts if mining operations last into hunting season. Some big game animals would avoid the area as a result of mining activities. However, from personal observation and literature review, it appears that big game wildlife

often tend to adapt to noise impacts in areas where they have adequate cover, browse, and escape routes. Impacts to recreational users and to big game are expected to be minimal. Stansbury has committed to monitor mine operations for nuisance effects. Stansbury has also agreed to restrictive use of jake brakes by ore trucks while in Ravalli County.

ALTERNATIVE 2

Little difference is expected regarding noise impacts from Alternative 2 versus Alternative 1. Bussing of mine workers to the project site would lessen road noise, and the disturbance would be much less frequent (perhaps one bus would displace 20 cars on the access road). Therefore, noise impacts would be decreased by bussing to the project site.

ALTERNATIVE 3

The No Action alternative would preserve the primarily quiet environment of the project vicinity after completion of reclamation. Some background noise may reach the project vicinity from future logging operations in other areas of the BNF. Localized noise impacts from potential logging activities, as noted in the baseline discussion, could reach the 80+ dBA range.

CUMULATIVE IMPACTS

Present noise levels vary from 40 dBA (normal rural conditions) to 85+ dBA (chain saws and heavy equipment used for logging). The proposed project may contribute to increased noise levels in the vicinity of the mine which are equivalent to logging and heavy equipment operation. The magnitude and intensity of these impacts combined with current and future activities is difficult to quantify.

RESOURCE COMMITMENTS

Noise levels would normalize after project closure. No long-term resource commitments are anticipated.

5.0 CONSULTATION AND COORDINATION

A formal period for submittal of comments on the project and on the scope of the EIS occurred prior to its preparation. Notification of the agencies' intention to prepare the EIS and announcement of a period during which public comments would be received regarding the EIS scope was published in the *Federal Register* on April 27, 1988 and in local and area newspapers. A public meeting to validate and update scoping concerns was held on May 24, 1990 in Hamilton, Montana. Other meetings were held throughout 1987-1990 in Hamilton and Butte to discuss the project and its impacts, involving various citizens, groups, and agencies (see Section 1.7, Public Participation).

DISTRIBUTION AND REVIEW OF THIS EIS

Copies of this draft EIS are being provided to approximately 300 persons, groups, local governments, and agencies that have expressed an interest in the Stansbury Project. The mailing list was compiled using the names and addresses of:

- parties who participated in the public meeting or who submitted written comments;
- parties who have requested copies of the EIS;
- agencies, governments, tribes, and companies potentially affected by the proposed operation; and
- agencies and groups consulted during the EIS preparation

A copy of this EIS can be reviewed at the following locations:

- Northern Regional Office, U.S. Forest Service
  Missoula, Montana
- Supervisor's Office, Bitterroot National Forest
  Hamilton, Montana
- Darby Ranger Station
  Darby, Montana
- Montana Department of State Lands
  Helena, Montana
- Montana Department of Health and Environmental Sciences
  Helena, Montana
- Montana Department of Natural Resources and Conversation
  Helena, Montana

- Ravalli County Library
- Missoula City-County Library

Copies of this document are also available on request from:

- Bitterroot National Forest
  PO Box 388
  Darby, Montana 59829

- Montana Department of State Lands
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APPENDIX A

HEALTH RISK ASSESSMENT

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1.0 INTRODUCTION

1.1 OVERVIEW

The Western Vermiculite Project is a proposed vermiculite surface mine in western Montana. The vermiculite ore deposit for this project, identified as ABM Ridge, contains varying amounts of amphibole minerals. Amphibole minerals can exist in either an asbestos or nonasbestos form. Since asbestos is a human carcinogen, the public has expressed concern regarding potential health risks from amphibole fiber emissions due to various mine-related activities. To evaluate this issue, a human health risk assessment was undertaken to quantitatively evaluate the potential health risks from amphibole fibers that could result from the proposed mining activities.

A fundamental assumption of this Health Risk Assessment (HRA) is that the amphibole minerals present in the ABM Ridge ore deposit have the same potential to cause adverse health effects as asbestos fibers. This assumption should not be construed as a conclusion by the authors that this is indeed the case. It is recognized that the majority, if not all, of the amphibole minerals present in the ore deposit exist in a nonfibrous form and would not be classified as asbestos. There is no available human health data concerning the health risks from exposure to nonasbestiform amphiboles. Thus, the assumption that exposure to ABM Ridge amphiboles is equivalent to asbestos exposure may overstate the risk.

The entire HRA is presented in this technical report and related appendices. A summary of this report and its conclusions is provided in Section 4.4 of the Western Vermiculite Project Environmental Draft Impact Statement (EIS).

1.2 SITE BACKGROUND

SITE DESCRIPTION

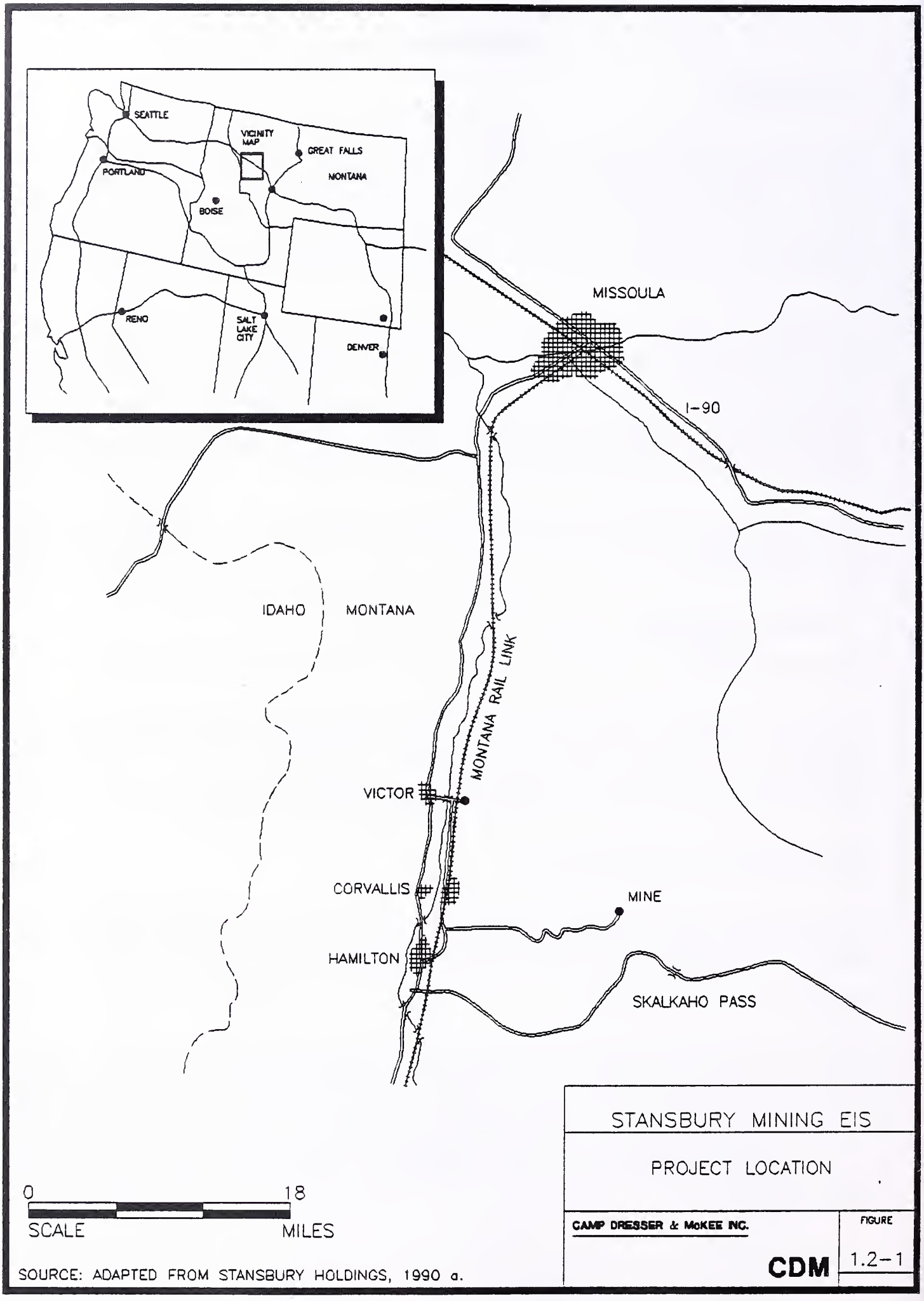
The Western Vermiculite Project is a proposed vermiculite surface mine located in Ravalli County, about 11 miles east of Hamilton, Montana (see Figure 1.2-1). The project would include an on-site ore concentrator and a host rock waste stockpile (HRWS). Concentrated ore would be trucked to an exfoliation plant in Butte, Montana. Stansbury Holdings Corporation is the owner and operator of the project. The estimated time required to mine the ore deposit covered by the EIS is 5-8 years.

ENVIRONMENTAL SAMPLING DATA

Very preliminary and limited environmental sampling data are available for amphibole fibers in air, soil and water near the site. Samples of vermiculite ore have been found to contain widely varying concentrations of several amphibole minerals, including actinolite.

OFFSITE AREAS OF INTEREST

The mine is located in a relatively remote area in the Bitterroot National Forest (BNF). Airborne emissions from mine-related activities, such as extraction, concentration, transportation and exfoliation could theoretically result in some level of recreational or residential exposure. The nearest residence to the mine site is about 6 miles away. The nearest town, Hamilton, is 11 miles to the west of the mine site. The proposed transportation route goes through several unincorporated communities and urban areas. The exfoliation plant in Butte is located in an industrial park where the closest residential area is about 1 mile away.


SEATTLE
VICINITY MAP
GREAT FALLS
PORTLAND
MONTANA
BOISE
RENO
SALT LAKE CITY
DENVER
MISSOULA
I-90
IDAHO
MONTANA
MONTANA RAIL LINK
VICTOR
CORVALLIS
MINE
HAMILTON
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0
18
SCALE
MILES
STANSBURY MINING EIS
PROJECT LOCATION
CAMP DRESSER & McKEE INC.
CDM
FIGURE
1.2-1
SOURCE: ADAPTED FROM STANSBURY HOLDINGS, 1990 a.

1.3 SCOPE

The purpose of the HRA is to evaluate the potential excess cancer risks from exposure to amphibole fibers resulting from operation of the Western Vermiculite Project mine. This is accomplished by estimating exposure levels and calculating potential excess cancer risks for selected exposure scenarios.

Exposure point concentrations are based on air dispersion modeling estimates derived from amphibole content of the vermiculite ore and typical dust emission factors for different mining and processing activities. Quantitative health risk estimates are prepared for several residential and recreational exposure scenarios. Population subgroups with possible special susceptibility to asbestos cancer risks, namely smokers and young children, are also considered. The route of exposure selected for evaluation is inhalation. Risk assessment methods used in the HRA are based on recent EPA guidelines (EPA, 1989), and are intended to obtain health risk estimates for a Reasonable Maximum Exposure (RME) for each of the exposure scenarios.

Health risks for workers employed at the mine are not addressed in this HRA because mine worker safety is the designated responsibility of a specific federal agency, the Mine Safety and Health Administration (MSHA). MSHA has promulgated standards for airborne asbestos fibers which would apply to the Western Vermiculite Project if airborne fibers meet the MSHA definition for asbestos. The asbestos standards are developed based on previous epidemiological studies involving workers in the asbestos mining and milling industry and are intended to maintain a safe and healthful working environment. If unsafe levels of airborne fibers occur at the mine, based on the results of MSHA's mandatory monitoring program, MSHA will determine appropriate emission controls for the mine site to be bring the site back into compliance with federal standards. It is not clear that any asbestos would be present at the mine site; MSHA sampling for asbestos during pilot plant operations was negative (MSHA, 1983).

1.4 ORGANIZATION OF THE RISK ASSESSMENT

The HRA is organized into the following sections:

- Section 2.0 Minerals of Potential Concern - identifies/defines the minerals of concern, evaluates the environmental sampling data and the basis for their inclusion in the risk assessment
- Section 3.0 Exposure Assessment - describes methods used to develop exposure estimates
- Section 4.0 Toxicity Assessment - discusses the toxicology of asbestos
- Section 5.0 Risk Characterization - provides estimates of potential health risks
- Section 6.0 Summary - summarizes the technical approaches and conclusions of the risk assessment
- Section 7.0 References
- Appendix

2.0 MINERALS OF POTENTIAL CONCERN

This section begins with an overview of mineralogy terms and definitions which are used to characterize the amphibole content of the ore and other media. The mineralogy of asbestos and related minerals is reviewed. Regulatory definitions are provided for asbestos fibers, and methods used to detect and characterize asbestos fibers in the context of health risks are briefly discussed.

The discussion of mineralogy presented here is brief, with an emphasis on the aspects of asbestos and asbestos-related minerals which are relevant to the Western Vermiculite Project. The information is extracted from several summary publications, including Asbestiform Fibers: Nonoccupational Health Risks (NAS, 1984), Pictorial Mineralogical Exhibit (AMC/NSA, 1989), Asbestos: An Information Resource (DHH, 1981) and Non-Occupational Exposure to Mineral Fibers (IARC, 1989). These and other sources are listed in the references section of this document.

Available environmental sampling data for the site and surrounding area for air, soil and water, as well for the ore deposit are then summarized. The sampling protocols, analytical methods, and quality assurance procedures for the various datasets are evaluated to determine the most appropriate dataset(s) to use for the Health Risk Assessment (HRA).

2.1 REVIEW OF MINERALOGICAL TERMS AND DEFINITIONS

The use of the term "asbestos" in both the scientific literature and the popular press is often inconsistent and confusing. The terminology used for other minerals related to asbestos can also be obscure. As a result, differences in the likelihood of potential health risks from exposure to these different minerals is easily overlooked or misunderstood.

ASBESTOS AND ASBESTIFORM HABIT

The term asbestos is used to identify a naturally-occurring group of fibrous hydrated mineral silicates which are used commercially because of their tensile strength and resistance to heat and chemicals. Confusion about the term "asbestos" is due to the fact that asbestos is actually a commercial-industrial term rather than a mineralogical one. There are three commercial varieties of asbestos which belong to two different mineral silicate groups. Chrysotile, which is the most commonly used variety of asbestos (95 percent of commercial market), belongs to the serpentine group of minerals. Crocidolite and amosite, which are presently used less frequently, belong to the amphibole group of minerals. Additional varieties of asbestos belonging to the amphibole group include anthophyllite asbestos, tremolite asbestos, and actinolite asbestos.

The term asbestos is applied to forms of these minerals that have a unique crystallization pattern which is manifested in thin and hairlike crystals or fibers. This crystallization pattern is due to specific environmental conditions, primarily temperature and pressure, present during crystal growth. The technical term for this crystallization pattern is "asbestiform habit". In addition to characteristic shape and appearance, asbestiform fibers also exhibit other characteristic properties, including flexibility, durability, and enhanced strength. The asbestiform habit is not unique to asbestos; there are natural fibers (fibrous clays, calcium metasilicates and zeolite minerals) which also exhibit many of the same properties and appearance of asbestos minerals. These other fibers are, however, not referred to as asbestos.

Each of the serpentine or amphibole minerals described above can also exist naturally in a nonasbestiform habit; that is, these minerals can exist in a form in which crystal growth is random and multi-dimensional. When the nonasbestiform mineral is crushed, the crystal fractures easily and the resulting fragments are typically shorter and thicker than asbestiform minerals. In some cases different names have been given to the asbestiform and nonasbestiform varieties of these minerals, while in other cases the same name is used for both mineral varieties. A list of these names is presented in Table 2.1-1.

Nonasbestiform silicate minerals typically do not share the characteristic physical properties of their asbestiform counterpart, such as strength, flexibility and resistance to heat. Nonasbestiform silicate minerals can also exhibit different optical properties when examined microscopically.

A distinction can be made between the different structures which result from crushing of asbestiform and nonasbestiform minerals. The thin, hair-like crystals released from asbestiform minerals are typically referred to as fibers. The shorter, thicker, more needle-like structures released from nonasbestiform minerals are often called cleavage fragments. It has been suggested that the potential health risks are considerably less for exposure to cleavage fragments than for exposure to fibers (Brown, et al., 1984; Higgins, et al., 1983; Cooper, et al., 1988).

The potential health risk from cleavage fragments is a controversial issue. Available data are scarce and equivocal. Regulatory agencies presently have conflicting positions; National Institute of Occupational Safety and Health considers fibers and cleavage fragment to have identical health risks (Lemen, 1990), while the Mine Safety and Health Administration does not regulate nonasbestiform minerals (i.e., those that form cleavage fragments) (Federal Register, 1989). Occupational Safety and Health Administration is currently reviewing occupational asbestos standards to decide if cleavage fragments should be regulated differently than fibers (OSHA, 1989). However, testimony to OSHA from Richard Lemen, Assistant Director of NIOSH, indicates that no distinction between fibers and cleavage products is defensible at this time.

For the purposes of the HRA, no distinction is made between fibers and cleavage fragments in terms of potential health risks. This is a conservative assumption which may result in an overestimation of potential health risks.

AMPHIBOLE MINERALS IN THE ABM RIDGE DEPOSIT

The vermiculite ore body to be mined by the Western Vermiculite Project is located in an area called ABM Ridge. Core samples of the ABM Ridge body show actinolite, tremolite, anthophyllite and cummingtonite-grunerite are present. Actinolite and cummingtonite-grunerite are the most common and present at the highest concentrations, while anthophyllite and tremolite are detected infrequently. In addition, another amphibole called hornblende is present in every core sample. This is a common constituent of surface rocks in the area. Hornblende exists only in the nonasbestiform habit and is a common rock-forming component in many areas. No hydrated silica minerals in the serpentine group were detected.

2.2 METHODS USED TO MEASURE FIBERS

In terms of potential health risks, the most important property of hydrated silica minerals is the amount, size and shape of the fibers which are released when these materials are handled and processed. Exposure to these fibers, especially by breathing, is the way in which these fibers can cause disease. However, the identification, measurement and characterization of "asbestos" and other fibers present in

TABLE 2.1-1

COMMON NAMES USED FOR ASBESTIFORM AND NONASBESTIFORM MINERALS[a]

Asbestiform	Nonasbestiform	Mineral Group	Chemical Formula
chrysotile asbestos	antigorite	Sepentine	$(MgFe)_6(OH)_8Si_4O_{10}$
crocidilite asbestos	riebeckite	Amphibole	$Na_2Fe_2^{3+}\ Fe_3^{2+}(OH)_2Si_8O_{22}$
amosite asbestos	cummingtonite-grunerite	Amphibole	$Mg_7(OH)_2Si_8O_{22}$ $Fe_7(OH)_2Si_8O_{22}$
anthophyllite asbestos	anthophyllite	Amphibole	$(MgFe)_7(OH)_2Si_8O_{22}$
tremolite asbestos	tremolite	Amphibole	$Ca_2Mg_5(OH)_2Si_8O_{22}$
actinolite asbestos	actinolite	Amphibole	$Ca_2Fe_5(OH)_2Si_8O_{22}$

[a] Adapted from IARC (1989), NAS (1984), and AMC/NSA (1989).

the environment is not simple. Different analytical methods have been developed over the years which measure various different aspects of fibers and provide different kinds of information. In some cases, fibers are defined by the measurement method which is used. For the purposes of health risk assessment, it is important to know how fiber measurements were made.

In this section, the regulatory definition for asbestos fibers used in the HRA is discussed. Several measurement methods for asbestos fibers are described and the types of information provided by these methods are explained. The environmental sampling and analysis methods used to characterize amphibole fibers at the ABM Ridge site and surrounding areas are also described.

The regulatory definition of asbestos fiber is not consistent and can vary among regulatory agencies. The current OSHA definition of asbestos fiber is used throughout this HRA because this definition is the most widely used. The OSHA definition of asbestos fiber is a mineral with the chemical composition of either the serpentine or amphibole group which has dimensions of length greater than 5 microns and an aspect ratio (length to width) of greater than 3:1 (OSHA 29 CFR 1910.1001). Figure 2.2-1 illustrates the criteria for designating a material as asbestos.

Airborne exposures in industrial settings involving asbestos are generally quantified in terms of concentrations of fibers retained on an air filter which have longer than 5 microns and have an aspect ratio (length to width) of greater than 3:1, when measured by phase contrast microscopy (PCM). This system was developed by a British asbestos textile company in the early 1960's and adapted by the U.S. Public Health Service in 1964. The concern in the 1960's, and presently, was for "long" fibers (fibers longer than 5 microns with an aspect ratio of 3:1 or greater) as these had been implicated in the development of asbestosis (Gardner, 1938). More recent animal experimentation beginning with that of Stanton (1977) suggests that it is also the long fibers which are important in the initiation of cancer. When the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value Committee adopted the British criteria of longer than 5 microns this also became the U.S. standard, and the phase contrast optical microscope count of fibers longer than 5 microns is now a world-wide standard method for quantifying occupational exposures.

The major drawbacks of PCM are that the technician generally cannot distinguish between asbestos and nonasbestos fibers and that the very thin fibers (e.g., fibers thinner than about 0.3 microns) can not be seen. When using scanning electron microscopy (SEM) and transmission electron microscopy (TEM), the microscopist can differentiate between asbestos and nonasbestos materials. Further, TEM has sufficient resolution to observe very thin asbestos fibers. However, these electron microscopy methods are also more time-consuming and expensive than PCM. A comparison of these microscopic analysis methods, uses and comparisons/disadvantages is provided in Figure 2.2-2.

Measurement of asbestos fiber content in material such as ore is more difficult than in air. The asbestos fibers must be liberated first from the medium in which they are contained before the fibers can be counted under the microscope. Approaches vary according the matrix of the ore, but typically include crushing of the ore sample, chemical treatment to remove interference materials, and resuspension of the ore particles in filtered water, followed by filtration of the ore solution. The particles left on the filter are then examined under a phase contrast or electron microscope. A flow chart for analysis of asbestos bulk samples is depicted in Figure 2.2-3.

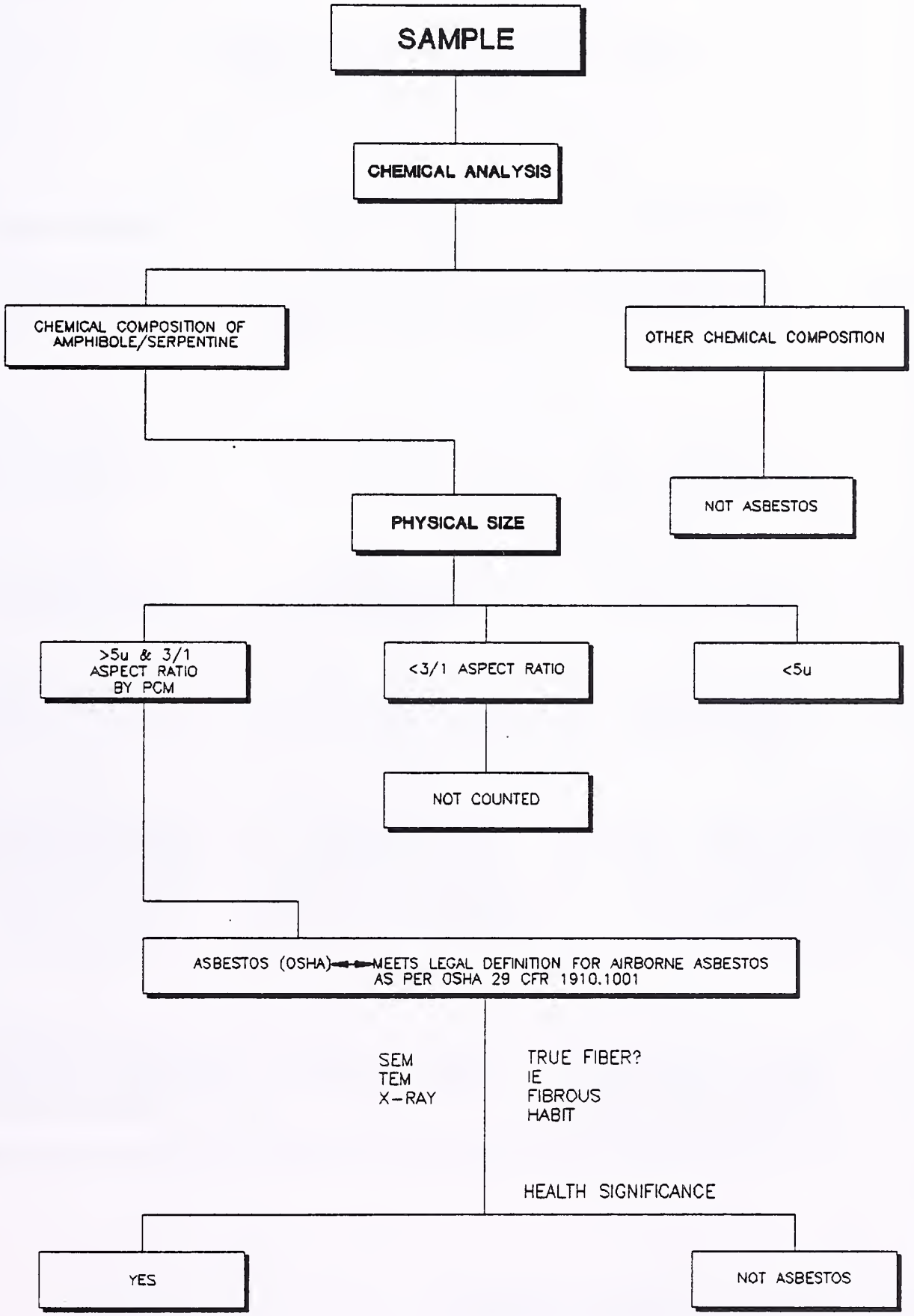
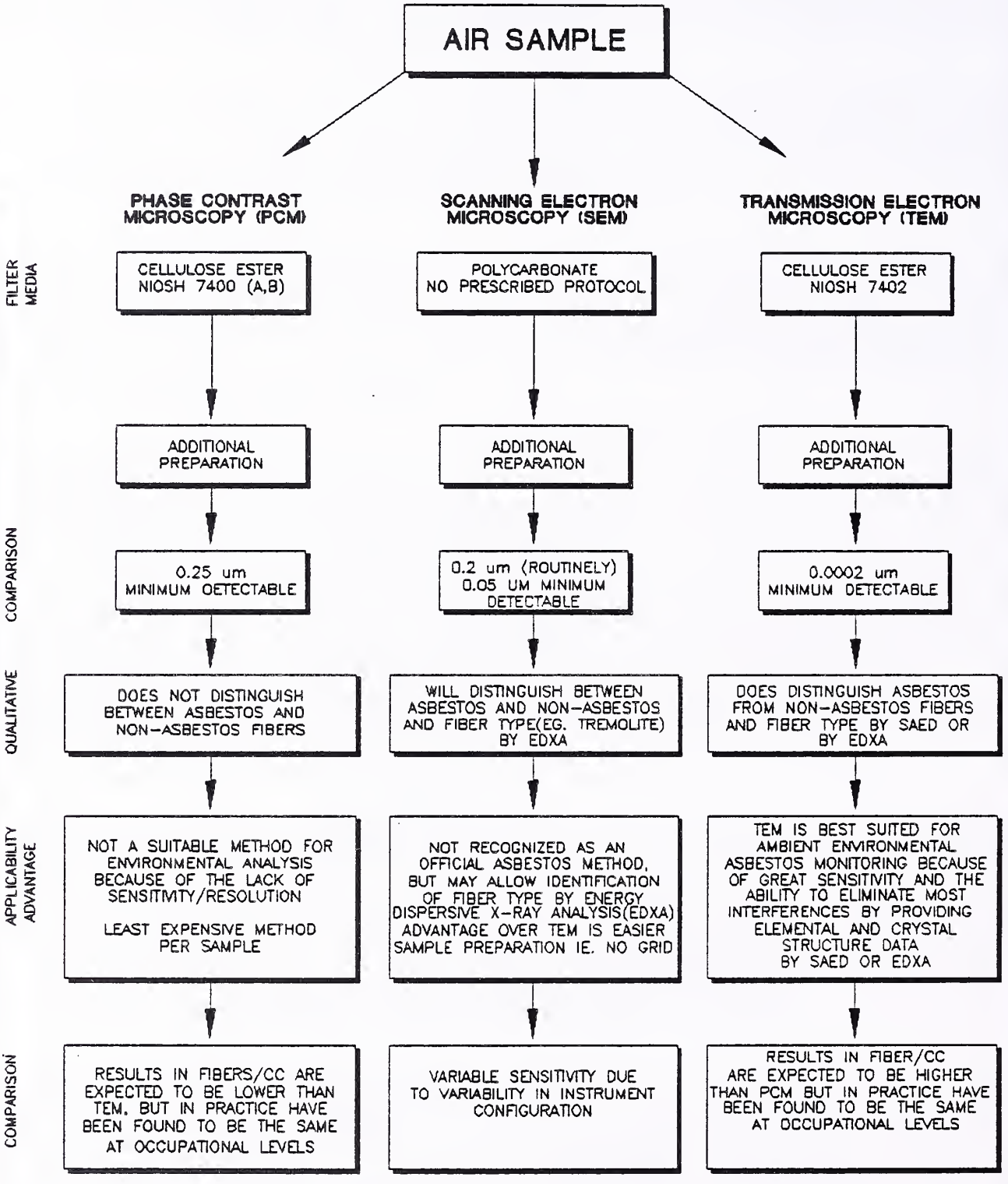


Figure 2.2-1 Asbestos Defined (OSHA)


AIR SAMPLE
PHASE CONTRAST MICROSCOPY (PCM)
SCANNING ELECTRON MICROSCOPY (SEM)
TRANSMISSION ELECTRON MICROSCOPY (TEM)
FILTER MEDIA
CELLULOSE ESTER NIOSH 7400 (A,B)
POLYCARBONATE NO PRESCRIBED PROTOCOL
CELLULOSE ESTER NIOSH 7402
ADDITIONAL PREPARATION
ADDITIONAL PREPARATION
ADDITIONAL PREPARATION
COMPARISON
0.25 um MINIMUM DETECTABLE
0.2 um (ROUTINELY) 0.05 UM MINIMUM DETECTABLE
0.0002 um MINIMUM DETECTABLE
QUALITATIVE
DOES NOT DISTINGUISH BETWEEN ASBESTOS AND NON-ASBESTOS FIBERS
WILL DISTINGUISH BETWEEN ASBESTOS AND NON-ASBESTOS AND FIBER TYPE(EG. TREMOLITE) BY EDXA
DOES DISTINGUISH ASBESTOS FROM NON-ASBESTOS FIBERS AND FIBER TYPE BY SAED OR BY EDXA
APPLICABILITY ADVANTAGE
NOT A SUITABLE METHOD FOR ENVIRONMENTAL ANALYSIS BECAUSE OF THE LACK OF SENSITIVITY/RESOLUTION
LEAST EXPENSIVE METHOD PER SAMPLE
NOT RECOGNIZED AS AN OFFICIAL ASBESTOS METHOD, BUT MAY ALLOW IDENTIFICATION OF FIBER TYPE BY ENERGY DISPERSIVE X-RAY ANALYSIS(EDXA) ADVANTAGE OVER TEM IS EASIER SAMPLE PREPARATION IE. NO GRID
TEM IS BEST SUITED FOR AMBIENT ENVIRONMENTAL ASBESTOS MONITORING BECAUSE OF GREAT SENSITIVITY AND THE ABILITY TO ELIMINATE MOST INTERFERENCES BY PROVIDING ELEMENTAL AND CRYSTAL STRUCTURE DATA BY SAED OR EDXA
COMPARISON
RESULTS IN FIBERS/CC ARE EXPECTED TO BE LOWER THAN TEM, BUT IN PRACTICE HAVE BEEN FOUND TO BE THE SAME AT OCCUPATIONAL LEVELS
VARIABLE SENSITIVITY DUE TO VARIABILITY IN INSTRUMENT CONFIGURATION
RESULTS IN FIBER/CC ARE EXPECTED TO BE HIGHER THAN PCM BUT IN PRACTICE HAVE BEEN FOUND TO BE THE SAME AT OCCUPATIONAL LEVELS

EDXA – ELECTRON DIFFRACTION X-RAY ANALYSIS
SAED – SELECTED AREA ELECTRON DIFFRACTION

Figure 2.2-2 Asbestos Air Sampling

Asbestos Bulk Sample Flow Chart

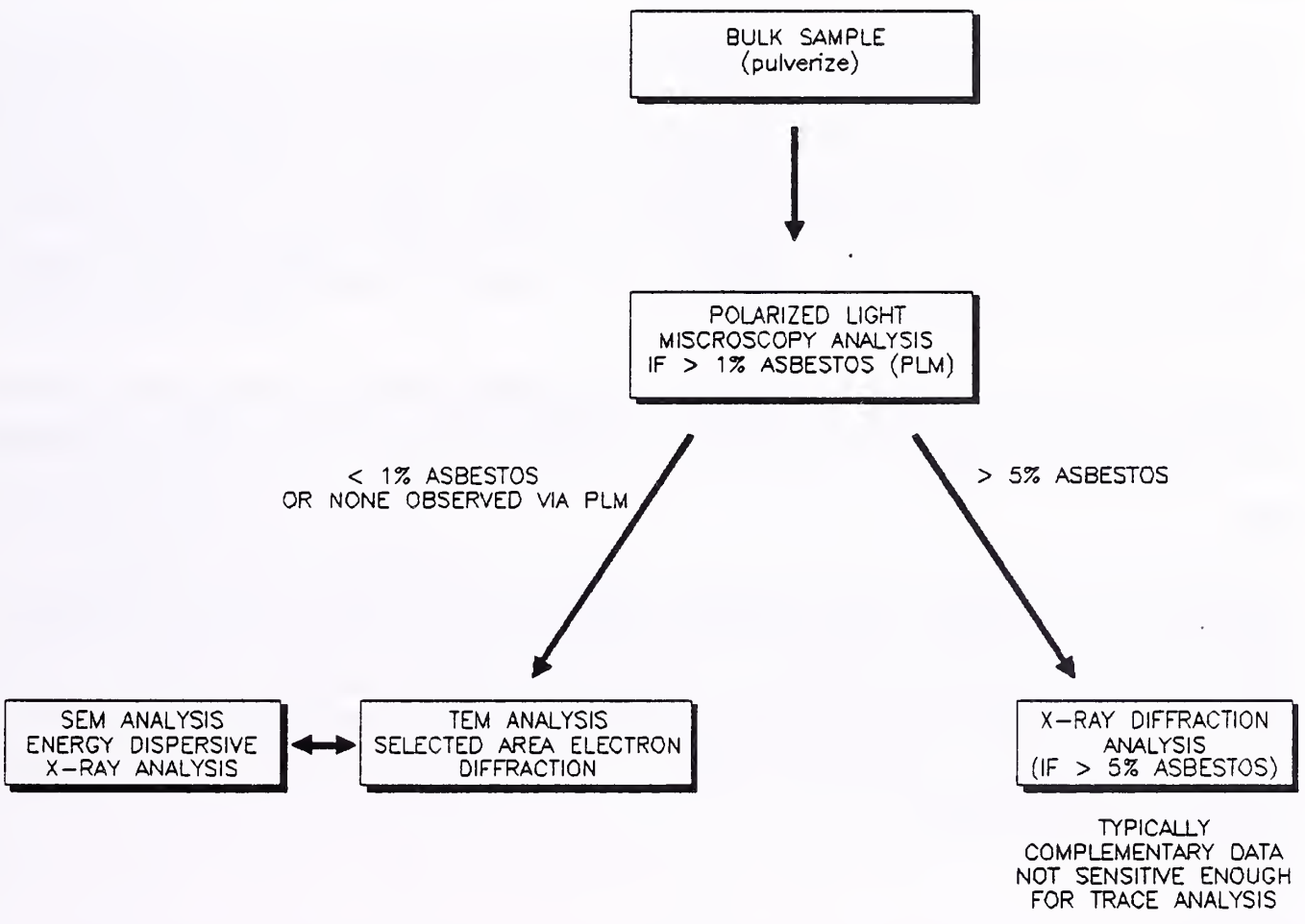


Figure 2.2-3 Asbestos Bulk Sample Flow Chart

2.3 EVALUATION OF ENVIRONMENTAL SAMPLING DATA

Very limited environmental data are available for air, soil and water from the Western Vermiculite Project and surrounding area. Extensive sampling data are available for the ore deposit itself. In this section, these data are evaluated for use in the risk assessment. It should be pointed out that these data were collected for a variety of reasons before a health risk assessment for the mine project was envisioned. Comments regarding the adequacy of the data for quantitative risk assessment should not be regarded as criticism of the methods or objectives for these sampling efforts.

AIR

A single air filter sample collected at each of six locations between the mine site and Hamilton by the Air Quality Bureau in the fall of 1987 were submitted to two different testing laboratories for asbestos analysis. Northern Engineering and Testing used a polarized light microscopy (PLM) method to measure fiber content, while Energy Technology Consultants (ETC) used TEM. The results are summarized in Table 2.3-1. The only confirmed positive sample for "asbestos" fibers was a sample taken near the access road to the mine which detected actinolite. The number of fibers detected in this sample was only slightly above the detection level. Sampling protocol, analytical methods, and quality assurance procedures were not reviewed for this report.

Air sampling during pilot plant milling operations at the proposed mine site was performed by MSHA in 1979. A five minute air sample was analyzed by scanning electron microscopy (SEM). No asbestos was detected (MSHA, 1983).

SOIL

Several surface samples taken by the Montana Air Quality Bureau throughout the area of interest were submitted to two independent testing laboratories to measure asbestiform mineral content. The results of the analyses are summarized in Table 2.3-2. PLM analysis detected "asbestiform materials" in surface soils from a field, a clear-cut in the Bitterroot National Forest (BNF) near the proposed mine site, the mine site itself and a downtown street in Hamilton (not further identified). SEM confirmed the presence of actinolite only at the mine site but the street and clear-cut samples were not assayed by TEM. No additional details are available.

WATER

Three water samples were collected in the area in 1987 and analyzed by TEM. In a single drinking water sample from the city of Hamilton, asbestos was not detected (detection level = 50,000 fibers/liter). A single raw water sample from the Bitterroot River near the Como Bridge was also negative (detection level = 190,000 fibers/liter). A single water sample collected by the Forest Service from St. Clair Creek below the proposed mine site counted 85,000 fibers/liter. However this sample was intentionally collected from turbid water and contained unknown amounts of sediment and debris from the stream bed. No other water data are available.

VERMICULITE ORE DEPOSIT

Considerable data for amphibole content of the vermiculite ore deposit are available. However many of the analyses are qualitative evaluations for the specific presence of asbestiform fibers. Generally the conclusions from these tests are that no asbestos or asbestiform minerals were present in core samples

TABLE 2.3-1

ASBESTOS CONTENT IN AMBIENT AIR
(fibers/cc)[a]

Sample Point	Northern Engineering[b] (all fibers)	Energy Technology Consultants (amphibole fibers)
County Shop	0.009	N.D.[d]
Downtown Hamilton	0.005	N.D.
Hamilton Heights Road[c]	0.005	N.D.
Interim Stockpile[e]	0.006	N.D.
Access Road (switchback)	0.006	0.01
Mine Site (ABM Ridge)	0.006	N.D.

[a] Fibers are defined structures longer than 5 microns with an aspect ratio of greater than 3:1.
[b] Polarized Light Microscopy
[c] Transmission Electron Microscopy
[d] N.D. - Detection limit 0.006 fibers/cc.
[e] Originally part of the mine plan but this site has since been removed by Stansbury.

TABLE 2.3-2

ASBESTIFORM MINERAL CONTENT IN SOILS
(Percent)

Sample Point	Northern Engineering[a] (all fibers)	Energy Technology Consultants[b] (amphibole fibers)
Hamilton Heights Road	0	< 0.1 (tremolite)
Interim Stockpile	0	NA[c]
Exfoliation Site (field)	0	ND[d]
Exfoliation Site (street)	1 - 3	NA
Downtown Hamilton	0	ND
Waste Rock Storage Site (road)	1 - 3	ND
Mine Access Road (1 mile)	0	
Mine Access Road (Mustard site)	0	NA
Mine Composite	1 - 6	0.12[e] (actinolite)

[a] Polarized light microscopy.
[b] Polarized light microscopy, computer controlled scanning electron microscopy, and manual scanning electron microscopy.
[c] Not analyzed.
[d] Not detected.
[e] Initial ETC results were 1-2% actinolite. The lab was requested to repeat the test by assaying a much larger sample to obtain a more representative sample. The results of the re-analysis are shown in this table.

from the ore deposit, although two of the nine test reports did report the presence of "fibrous minerals" or "small amount of asbestos". Summaries of these tests are contained in ABM RIDGE ASBESTOS ANALYSIS (USFS/DSL, 1988).

Quantitative measurement of fibers present in the ore deposit was reported in an analysis performed by RJ Lee (1988a). These studies were undertaken jointly by Montana Department of State Lands (DSL) and the Bitterroot National Forest (BNF) to determine the mineral and fiber content of ore deposit cores previously drilled by Stansbury Holdings Corporation during mine exploration and development activities of the ABM Ridge. A total of 29 core samples were analyzed by Polarized Light Microscopy. Selected samples were also evaluated by SEM and X-ray spectrometry. These studies provide quantitative information on mineral composition of the ore and volume percent amphibole fiber composition. The raw data from these studies are presented in Appendix A-1. Sampling and analytical details are provided in ABM RIDGE ASBESTOS ANALYSIS (USFS/DSL, 1988). The conclusions from these studies are:

- of the amphibole minerals present in the ore, only actinolite and hornblende produced fibers after crushing and processing
- the average percent by volume of total ore sample comprised of actinolite and hornblende fibers longer than 5 microns and with an aspect ratio of 3:1 or greater is 0.3 percent
- no "asbestiform minerals" in these core samples and no "true fibers" were detected in any of the samples

Considerable variability in amphibole mineral composition is apparent from the results of this study. Wide variations in amphibole composition in the ore deposit are likely due to the apparent concentration of amphibole minerals in several dikes or stringers which penetrate the ore body in several locations. Subsequent analysis of concentrated ore indicates much lower amphibole concentrations, presumably due to separation of the vermiculite from the amphibole-containing waste rock (RJ Lee, 1988b).

INDEPENDENT REVIEW OF DRILLING AND SAMPLING METHODS

The drilling and sampling methods used by Stansbury Holdings Corporation and the agencies to characterize the ore deposits and in particular, amphibole percentage composition of the ore body, have been submitted to three independent mining geologists for review. The experts selected were: Paul Pierce, Geologist, U.S. Bureau of Mines; Peter Knudsen, Professor of Geology, Montana Tech.; and Ken Black, Mining Geologist, CDM. These reviewers concluded that:

- spacing and number of drill holes for evaluation of ore deposit are consistent with standard mineral exploration practices
- two angle holes appear to have intersected the primary calcite actinolite veins and are thus appropriate
- selection of holes throughout deposit, rather than a random selection procedure, is the correct approach to characterize amphibole content of the ore

It was also noted that although additional sampling could be performed for the ABM Ridge deposit to further characterize the location and distribution of amphibole minerals, the experts believed that adequate

characterization had already been achieved (Pierce, 1990, Knudsen, 1990, Black, 1990). Copies of their reports are available in the project files.

2.4 DATA EVALUATION

The air data did not provide quantitative measurements that could be used in a risk assessment. The analysis performed by Northern Engineering used PCM, which cannot distinguish between asbestos and other fibers. The analysis performed by Energy Technology Consultants, used TEM, but all sample measurements were reported as below the sample detection value, except for one sample taken from the mine access road. The air data also represent a single time point prior to commencement of mine operations, and provide no indication of the range or airborne fiber concentrations which might occur under actual mining conditions. For these reasons, the air data do not provide useful information for quantitative health risk assessment.

The soil data were intended to provide preliminary information of a screening nature regarding asbestos levels in the community and nearby areas of interest. These data are too imprecise and too limited to be of use in a quantitative health risk assessment.

The RJ Lee studies described above provide the only quantitative estimates of amphibole fibers present in the ore body. The drilling and sampling procedures used to collect the samples have been evaluated by the USFS, DSL, and three independent reviewers, and deemed adequate to characterize the ore deposit. Although strict chain-of-custody procedures were not maintained throughout the sampling and analysis efforts, documentation of the sample preparation activities appears to be adequate. The analytical laboratory methods and procedures are commonly used for these sorts of analyses and adequate descriptions of these methods are provided. Four check samples were submitted to an independent test laboratory, Environmental Testing and Technologies (ETT) for verification of the initial results. The check sample results were comparable with the RJ Lee quantitative results, given the type of analysis and low amphibole fiber concentrations in the ore deposit (ETT, 1988).

These are the only data that appear to provide an adequate basis to perform a quantitative health risk assessment.

2.5 SUMMARY

Mineral characterization studies sponsored by BNF and DSL indicate the presence of several amphibole minerals in the ABM Ridge vermiculite ore deposit. Hornblende, cummingtonite-grunerite and actinolite are present in highest concentrations, and these minerals are reported in nearly every sample. Tremolite and anthophyllite are generally present at much lower concentrations and are present in only a few samples.

Environmental sampling data for amphibole fibers are very limited except for the ore body itself. Air, water and soil samples collected from the area of interest are too limited in scope to be used in a quantitative risk assessment. Further, they were collected prior to commencement of mining operations and may not represent concentrations that may be present after the mine begins operations. The only environmental sampling data which are suitable for quantitative risk assessment are the fiber analyses sponsored by the BNF and DSL to evaluate amphibole content of the ore. These analyses were performed by RJ Lee and show the presence of actinolite and hornblende fibers at low concentrations in

several ore samples. These datasets appear to be of sufficient quality to support a health risk assessment. The amphibole fibers of potential concern are therefore actinolite and hornblende, and the dataset presented in the RJ Lee reports is used to estimate amphibole fibers concentrations in the raw ore.

3.0 EXPOSURE ASSESSMENT

This section describes the methods and assumptions used in the risk assessment to develop estimates of exposure to amphibole fibers under different exposure conditions. The exposure assessment begins with an evaluation of potential exposure pathways and routes. Exposure point concentrations are developed for several potential exposure situations using analytical data for fiber content of the ore, dust emission factors for typical mining activities and air dispersion models. Relevant exposure scenarios are identified. Assumptions and uncertainties associated with these methods are discussed in the context of their impact on the risk assessment results.

3.1 EXPOSURE ANALYSIS

As mentioned previously, there are no environmental sampling data for air, soil or water which are extensive enough to be used for this risk assessment. Since the mine has not yet been developed, a prospective approach must be used to estimate potential future exposures.

It is difficult to identify all significant exposure pathways and routes of exposure without knowledge of actual emission rates for fibers during mining-related activities and the transport of these fibers through the environment. However it seems likely that airborne fibers will represent the major exposure pathway and inhalation will be the primary route of exposure. Ingestion of fibers from water or soil is unlikely to be important, based on estimates of air concentrations obtained from air dispersion models.

3.2 ESTIMATION OF FIBERS PER GRAM ORE

Exposure point concentrations refer to the concentration of airborne amphibole fibers at various distances from the mine site or other potential fiber-generation sources, such as the exfoliation plant. Development of exposure point concentration estimates for this risk assessment involved three discrete steps. First, the number of amphibole fibers contained in a unit of vermiculite ore was estimated. This number was combined with dust-emission parameters for various mining-related activities to estimate the amount and rate of fiber release to the environment. This number is referred to as an emission rate. The amphibole structure emission rates for various mining activities were then used in two different air dispersion models to estimate airborne fiber concentrations at various locations of interest. These steps are described in detail in the following sections.

The air quality models used in this assessment generally use as input the amount by weight of material being emitted into the air per unit time (e.g., grams per second) at a source, and predict resulting air concentrations in terms of the amount of material per volume of air (e.g., in units of milligrams per cubic meter). On the other hand, health risks from exposure to asbestos are quantified based on the concentration of asbestos structures in the air (e.g., in units of fibers per cubic centimeter) in certain size ranges. Thus, in order to use the results of the air quality modelling to assess the impact of exposure upon human health, it is necessary to have an estimate of the number of amphibole fibers per gram of ore.

RJ Lee (1988a) estimated the volume percent of ore that is comprised of amphibole fibers, but did not estimate the number of fibers per unit ore. To estimate the volume percent, RJ Lee analyzed data from 29 core samples from the Stansbury site. For this analysis, it is assumed that material in these 29 cores are representative of the mineral composition of the site.

Table I of RJ Lee (1988a) contains estimates of the percent by volume of actinolite and hornblende in each sample which were the only two amphiboles found in the analyses (Appendix A 1). These estimates were based upon Computer-Controlled Scanning Electron Microscopy (CCSEM).

Table II of RJ Lee (1988a) contains percent by volume of actinolite and hornblende structures that are at least five microns long and with an aspect ratio of at least 3:1 (termed "federal fibers" by RJ Lee Group) (Appendix A 1). The volume percent of ore represented by all federal fibers comprised of amphibole was estimated using CCSEM. This total percent was divided into percents represented by actinolite and hornblende separately based upon polarized light microscope (PLM) analysis of 100 structures from each core sample and scanning electron microscopy (SEM) analyses of 50 structures from each sample (personal communication from RJ Lee to K.S. Crump, 1990).

Table III of RJ Lee (1988a) applies to structures longer than 5 microns and with at least a 10:1 aspect ratio, and was developed by a method analogous to that used for their Table II (Appendix A 1).

Data on the dimensions of the individual amphibole structures found in the SEM analyses conducted by RJ Lee are used for this analysis. These data indicate that many of the structures included in the RJ Lee analyses had diameters of three microns or greater and therefore were not respirable. Data of Raabe (1984) indicate that spherical structures larger than 10 microns in diameter are nonrespirable and Harris and Timbrell (1977) indicate that a fibrous structure with a 3:1 or greater aspect ratio has an aerodynamic diameter equal to about three times the actual diameter.

Assuming that the CCSEM analyses can accurately distinguish between amphibole and non-amphibole minerals, that these methods do not preferentially count particles in a particular size fraction, and that these analyses can detect particles with a diameter greater than 0.2 microns (the stated sensitivity for these analyses) then the results in RJ Lee's Tables II and III should be reasonable estimates of the percentage of the material in a sample that is composed of amphibole particles longer than 5 microns and with a greater than 3:1 aspect ratio, or greater than 10:1 aspect ratio, respectively. In order to estimate the number of amphibole structures per gram of ore from these data, it is necessary to adjust the results in these tables so that they refer to respirable structures only, and to estimate the average weight of the various categories of amphibole structures that are of interest.

The individual fiber data from the SEM analyses are reported in R.J. Lee (1988a). These data contain lengths and widths for 746 hornblende structures and 93 actinolite structures. Assuming structures are cylindrical, the respirable amphibole structures (i.e., those with an diameter of 3 microns or less) comprise 11 percent of the total mass of amphibole structures. Further, 26 percent of the total mass of hornblende structures was respirable and 2.3 percent of the total mass of actinolite structures was respirable.

In the SEM analyses, the dimension of a fiber is generally reported as a whole number of microns or as a whole number plus 0.5 micron. Only two fibers were reported with a diameter of less than 1 micron. By way of contrast, of the 40 actinolite fibers found in TEM analyses performed by both RJ Lee and EMSL Laboratory (USFS/DSL, 1988), 70 percent had diameters less than one micron. Therefore the dimensions of fibers reported in the SEM analyses were perhaps estimated only very crudely and may not be representative.

If the thinner fibers are under-reported in the SEM fiber data base, use of this data base would underestimate the percentage by weight of the respirable fibers. However, this underestimation would probably be minimal unless the vast majority of fibers are less than 1 micron thick, which seems unlikely

(this is because it would take a large number of very thin structures to offset the contribution to total mass of a nonrespirable structure). On the other hand, if the thin fibers are represented in the data base, but their diameters are reported as being greater than they actually are, (which seems more likely) then the data base would overestimate the percentage by weight of respirable fibers. In summary, it seems reasonable to use the data from the manual SEM analyses to estimate the percentage by weight of respirable structures. If this approach is biased, the bias should be in the direction of overestimating the percentage of respirable fibers, which would result in an overestimate of exposure.

On the other hand, if either thin fibers are under-represented in the data base, or if the diameters of the thinnest fibers are overestimated, the data base will overestimate the average weight of a respirable fiber. The bias caused by this will be in the direction of underestimating exposure. Further, this bias is potentially much larger than the bias discussed in the previous paragraph. Consequently, to estimate the average weight of a respirable fiber, in addition to use of the SEM data, the TEM data will also be considered.

Assuming a density for amphibole of 3 grams per cubic centimeter, and that fibers 3 microns or less in diameter are respirable, the average weight of a respirable amphibole fiber in the SEM data base is 115 picograms (pg). The corresponding average weight of the 40 amphibole structures found in the TEM analyses (all of which were respirable) was 33 pg. This value may be too low since the TEM analysis conducted by EMSL was restricted to fibers with a 5:1 or greater aspect ratio and consequently may have omitted some of the thicker fibers.) Nevertheless, an average weight of 30 pg/fiber will be considered to be representative.

From RJ Lee's Table II, the average percent by volume of total ore sample comprised of amphibole structures longer than five microns and with an aspect ratio of 3:1 or greater is 0.301 percent. Assuming percent by volume is a reasonable approximation of percent by weight, a representative value for the average number of respirable amphibole structures longer than 5 microns and with an aspect ratio of 3:1 or greater per gram of ore is estimated as

$$(0.00301)(0.11)(10^{12}\ \text{pg/g})/(30\ \text{pg/f}) = 1.1 \times 10^{7}\ \text{f/g},$$

or eleven million fibers per gram. Since there is some uncertainty in the estimate of the average weight of a respirable fiber, to calculate an upper bound on the number of respirable amphibole structures per gram of ore, we will assume that an average structure weighs 1.1 pg, which is the weight of a structure five microns long and 0.3 microns thick. (This seems clearly to be an upper bound; if, in fact all of the structures longer than 5 microns detected by TEM had a greater estimated weight.) The corresponding upper bound for the number of respirable amphibole structures per gram of ore is

$$(0.00301)(0.11)(10^{12}\ \text{pg/g})/(1.1\ \text{pg/f}) = 2.7 \times 10^{8}\ \text{f/g}.$$

The structures included in these estimates consist mainly (perhaps wholly) of cleavage fragments (see USFS/DSL, 1988). Since it is questionable as to whether cleavage fragments have the same carcinogenicity as fibers (or even whether they are carcinogenic at all), it is useful to make similar calculations based on structures longer than five microns and with a greater than 10:1 aspect ratio (called "true fibers" in RJ Lee report). These structures may be more appropriate as input to the risk assessment models based on workers exposed to fibrous material.

The average weight of the 26 respirable fibers in the SEM data base that had an aspect ratio of 10:1 or greater was 114 pg/f, and the corresponding average of the 20 fibers found by TEM that were longer than

5 microns and with an aspect ratio of 10:1 or greater was 28 pg/f. Consequently, an average weight of 25 pg/f will be considered representative.

From RJ Lee's Table III, the average percent of the total sample comprised of amphibole structures longer than five microns and with an aspect ratio of 10:1 or greater is 0.0048 percent. From the SEM data, the percent of total mass of structures with a 10:1 aspect ratio or greater that is comprised of respirable fibers is 39 percent.

Thus, a representative value for the average number of respirable fibers longer than 5 micron and with an aspect ratio of 10:1 or greater per gram of ore is estimated as

$$(0.000048)(0.39)(10^{12}\ \text{pg/g})/(25\ \text{pg/f}) = 7.5 \times 10^{5}\ \text{f/g},$$

or 750,000 fibers per gram. As an upper bound, we will assume, as before, an average fiber weight of 1.1 pg. The corresponding upper bound for the number of respirable fibers per gram of ore is

$$(0.000048)(0.39)(10^{12}\ \text{pg/g})/(1.1\ \text{pg/f}) = 1.7 \times 10^{7}\ \text{f/g}.$$

Each of the estimates made thus far have included both hornblende and actinolite. However, although hornblende is a variety of amphibole, there is no verified occurrence of hornblende asbestos (Campbell et al., 1979), and no direct evidence that exposure to hornblende is carcinogenic. Consequently, it may be more appropriate to consider only exposures to actinolite in this assessment. From RJ Lee's Table II, the average percent by volume of total ore sample comprised of actinolite fibers longer than five microns and with an aspect ratio of 3:1 or greater is 0.04 percent. From the SEM data, the percent of total mass of actinolite structures with a 10:1 aspect ratio or greater that is comprised of respirable structures is 2.3 percent. If we assume a representative value the average weight of an respirable fiber of 30 pg/f, the estimated number of respirable actinolite fibers per gram of ore is

$$(0.0004)(0.023)(10^{12}\ \text{pg/g})/(30\ \text{pg/f}) = 3.1 \times 10^{5}\ \text{f/g}.$$

If we assume a lower bound average weight of 1.1 pg/f, the estimate becomes 8.4×10^{6} f/g.

A range of 3×10^{5} - 3×10^{8} amphibole structures per gram of ore was obtained in the analyses presented above. However, the assumptions leading to the highest estimates seem implausible. To ensure a reasonably conservative risk assessment, a value of 3×10^{7} structures/g ore was selected.

3.3 FIBER EMISSION ESTIMATES

PARTICULATES

A common problem in the field of ambient air quality is the estimation of emissions from a facility which has not yet been constructed. One tool developed by EPA to assist with this estimation is a compilation of emission sources from many existing industries. The compilation is usually distilled to an "emission factor" which is a measure of emissions as a function of a process (such as material processed, heat-input, etc.). This document is "*AP-42, Compilation of Air Pollutant Emission Factors, Volume I. Stationary Point and Area Sources,*" (EPA, 1988).

Since this is a nationally recognized source of information and methodology for estimating emissions, this document served as the primary method of estimating particulate emissions. Unfortunately, there are no

categorized set of emission factors exclusive to the vermiculite industry (except perhaps perlite furnaces). There are, however, a number of emission factors for related types of industries and emissions. For example, there are emission factors for activities such as conveyors, screening operations, vehicular road dust, loading and unloading of trucks (batch dumping), etc. These values were used as a surrogate estimate for the proposed project.

In order to make an estimate of the emissions, one must also know the extent of the proposed emission source. This would include data regarding the total quantity of mined material, the estimated quantity of concentrate produced, the number of vehicles used, etc. This information was taken almost exclusively from the latest submittal by Stansbury Holdings Corporations to the Montana Department of State Lands (DSL) and Bitterroot National Forest (BNF), titled "Amendment to Operating Permit No. 00094", May, 1990 (Stansbury Holdings Corporation, 1990a). The only other source of data necessary to carry out the emission estimates was data related to vehicles. In particular, hauling distance is directly proportional to emissions. For this data, USGS maps and various other maps contained in Stansbury's permit application (1990) were consulted.

A complete record of all calculations used to estimate the particulate emissions from the project is contained in the project file (Bison Engineering, 1990). A summary of this information is contained in Table 3.3-1. The summary includes emissions from the proposed exfoliation plant and an estimate of the emissions that could occur if a truck containing concentrate were to spill its load on or near a highway.

FIBERS

The development of emission estimates for particulates was based upon a set of recognized documents and procedures. Similar procedures do not exist for the determination of the fiber releases. To calculate the quantity of fiber emissions released into the atmosphere from mine-related activities, a combination of mass emissions data combined with laboratory analyses of the ore samples was used. Estimates of amphibole fibers per unit of ore were developed based on assumptions regarding relationships between weight and number of fibers in the ore. A detailed discussion of methods used to derive fibers present per unit of ore is provided in the previous section (3.2).

The results of this analysis indicated a range of possible values from 3×10^5 - 2.7×10^8 fibers/gram of ore. A value from the upper end of this range, 3.0×10^7 fibers/gram, was chosen for most of the modeling work that follows. However, two exposure situations identified in the HRA involve ore concentrate, rather than raw ore. Data for ore concentrate were much more limited than for the raw ore. For these exposure situations, amphibole fibers/unit ore were arbitrarily set at half the raw ore value, or 1.5×10^7 fibers/gram. This value is likely to overestimate the actual fiber content because the limited analytical data available (RJ Lee, 1988b) indicate fiber concentrations at least ten times lower than those in the raw ore. However, results from only three samples of ore concentrate are presently available and a conservative approach to fiber estimation was selected.

3.4 AIR DISPERSION MODEL

METEOROLOGICAL DATA

Data Requirements

The necessary meteorological parameters which are required to estimate ambient air quality impacts are dependent upon the chosen dispersion model. These variables are: wind speed, wind direction,

TABLE 3.3-1

PARTICULATE EMISSIONS SUMMARY

Emission Category	Emission Estimate (tons/year)
Topsoil removal	0.32
Scraping using bulldozer etc.	7.23
Load ore to trucks	0.15
Load ore to conveyor (from trucks)	0.079
Conveying	0.040
Wind Erosion of Mine Site	0.063
Concentrator Process	0.52
Concentrate Loadout (to trucks)	0.022
Concentrator Waste Loadout	0.14
Disposal Area Loadout	0.29
Wind Erosion of Disposal Area	0.12
Vehicle Dust from Waste Hauling	5.79
Vehicle Dust from Concentrate Haul	69.4
Vehicle Dust from Service Vehicles	20.6
Accidental Vehicular Spill	0.14
Perlite Furnace (exfoliation	1.58
Vermiculite Furnace (exfoliation)	1.58
Exfoliation Processing	0.22
Unload Concentrate	0.024
Unload Perlite	0.049
Load Exfoliation Waste to Trucks	0.23
Load Product to Trucks	0.23
Wind Erosion from Concentrate Store	0.76

temperature, atmospheric stability, and mixing height. Each variable is required on an hourly basis (except for the truck spill scenario described below).

Data Sources

The model demands for meteorological data are rigorous and it is important that the meteorological data be representative of the area in question. The two variables which are most influenced by local conditions are wind speed and wind direction. Other variables such as temperature, mixing height, and stability class are more characteristic of larger scale meteorology.

Wind Speed, Wind Direction, and Temperature

For this project, wind speed, wind direction, and temperature were all available from a nearby monitoring system. In the case of the mine area, an on-site meteorological system had been operated by Stansbury. The system was located on Horse Ridge about 0.5 mile to the east of the proposed mine. The data was available from June through August, 1987.

The only other data set for wind speed and direction is the Missoula Airport. While the airport provides a more complete record, this is not the ideal choice. The on-site data are far superior since they directly accounts for winds as a result of local topography etc. The only disadvantage to the on-site data is the lack of a complete time period.

It was decided to use the Horse Ridge data even though a more complete record is preferred. The data included 3 of the 6 months in which the mine and concentrator may be expected to operate. The data, therefore, is indicative of anticipated wind speeds and directions during the operational period of the project.

For the exfoliation plant, no on-site data is available. A meteorological system has recently been installed at a nearby elemental phosphorous plant (Rhone-Poulenc) but data are not yet available. The nearest alternative station is the Butte airport. The airport is less than 10 air miles from the proposed site and has a similar valley orientation (north-south). Thus, this meteorological site was chosen.

The meteorological data from the airport (and all other airport locations throughout the US) is catalogued and stored by the National Climatic Data Center (NCDC) in Asheville, North Carolina. According to their records, the last year of record in which hourly data was reported was 1960. Since 1960, data have been reported every three hours. It was decided to use the 1960 year since it was a complete year and meteorology is not generally influenced by the year of record.

In order to calculate impacts from a truck spill scenario, one must consider where the spill may occur. For purposes of this project, the spill could occur anywhere between the concentrator (near the mine site) to the exfoliation plant in Butte. It would be virtually impossible to model ambient impacts at each location using site-specific meteorological data.

For this scenario, therefore, the model input was changed. Rather than provide a specific wind direction and wind speed, the data input was modified to include all possible combinations of wind speed, direction, stability class, etc. In essence, the model was instructed to search out and find the worst possible combination of meteorological events that would lead to the highest ambient impact.

Stability Class and Mixing Height

The stability classification and mixing height of the atmosphere are not as strongly influenced by local terrain as wind speed and direction. In addition, these two parameters are not as easily measured as direction, speed, and temperature. Mixing height, in particular, is very difficult to measure. It can only be determined through the use of acoustic sounders or upper air balloon soundings. While stability class can be determined using reasonably available meteorological sensors (wind sigma generator or the measurement of the standard deviation of wind direction using a computerized data acquisition system), this parameter was not measured on the mine site. Stability can be calculated if one uses nearby cloud cover data. The nearest source of data for cloud cover was the Missoula airport. This data is available from NCDC for 1987 (the year of record for wind speed, wind direction, and temperature). This cloud cover data was used along with calculations for sun angle and on-site wind speed to determine the appropriate stability class for each hour during the 3-month period.

The stability class for the exfoliation plant was calculated using the Butte Airport data previously mentioned. Cloud cover, sun angle, and temperature from Butte were all used to determine hourly stability classifications for the entire year (1960).

The nearest available balloon soundings data near Hamilton is Spokane, WA and Great Falls, MT. For purposes of calculating mixing height, the Spokane data were chosen. The balloon soundings data was merged with on-site temperature data to calculate hourly mixing heights.

Although the distance between Spokane and the mine site may seem large, it is a common practice to use data from such distant sites for determining mixing height. There are two reasons. The first is a matter of availability. Mixing height data is very expensive and time-consuming to generate on-site. The second is that the mixing height is, on a relative scale, insensitive to the model results. This is especially true for receptor locations near the emission source. Thus, it is generally believed that errors in mixing height will only have a minimal impact upon the predicted results.

For the exfoliation plant, it was decided to merge the 1960 Great Falls data with the Butte data in order to determine mixing height. The data was recorded on an hourly basis using methods described by the modeling guidelines.

Table 3.4-1 provides a summary of sources for each data variable used in the models.

DATA PREPARATION

All of the data was assimilated in accordance with the data sources noted above. The models, however, require that the data be prepared and input in a specific format. A computer program called RAMMET was used to generate the necessary model-compatible file.

RAMMET makes the previously referenced calculations for stability class, mixing height etc. The program, however, requires that there be a complete year of data to complete the processing. For Butte, this presented no problems. The on-site data near Hamilton, however, had to be manipulated in order to run the program. The months of January through May and September through December were filled with the June, July, and August data. When the model was executed, however, instructions were to only process the months with valid data.

TABLE 3.4-1

SOURCES OF METEOROLOGICAL DATA

Mine Site	Wind Speed	On-Site
	Wind Direction	On-Site
	Temperature	On-Site
	Stability	On-Site Temperature
		Missoula Cloud Cover
		On-Site Wind Speed
		Missoula Solar Angle
	Mixing Height	Spokane Balloon Soundings
		On-Site Temperature
Exfoliation	Wind Speed	Butte Airport
	Wind Direction	Butte Airport
	Temperature	Butte Airport
	Stability	Butte Temperature
		Butte Cloud Cover
		Butte Wind Speed
		Butte Solar Angle
	Mixing Height	Great Falls Balloon Sounding
		Butte Temperature

The ISC long term model requires the preparation of a "STAR" data set. A STAR data set is a frequency distribution of the wind speeds and directions by stability class. The data set was generated by analyzing the output data from the RAMMET data. For Butte, the entire year's data were used while only the months of June through August were used for the mine site analysis.

MODEL SELECTION

As noted earlier, it was decided to use the EPA's criteria for model selection. A review of the Guideline on Air Quality Models (Revised) (EPA, 1987) indicates that two classes of models would be appropriate in this situation. The first is the use of a model which is applicable to simple terrain (terrain below stack height). The second is the use of a model which takes into account complex terrain (terrain above stack height).

For complex terrain, the Guideline offers three possible screening model applications (Section 5.2.1 of the Guideline): VALLEY, COMPLEX 1, and SHORTZ/LONGZ. The latter model was rejected since its primary use is in urban situations. Complex 1 seemed a better choice over Valley since this model provides a more comprehensive analysis of ambient impacts due to its use of meteorological input on an hourly basis.

Despite the presence of complex terrain (both mine site and exfoliation plant), there are large sections of land which are either flat or gently sloping. The guideline document prefers that these areas be modeled using a different model. Among the choices for this type of modeling are ISC (Industrial Source Complex), RAM, PTPLU-2, and others. Section 7.2.1 of the guideline document, however, suggests that ISC is the model of choice where fugitive emissions are concerned. (Fugitive emissions are classified as emissions which do not exit from a stack or vent. An example includes road dust, wind erosion. etc.). For this project the majority of the emissions are classified as fugitive. Thus ISC was chosen for the simple terrain.

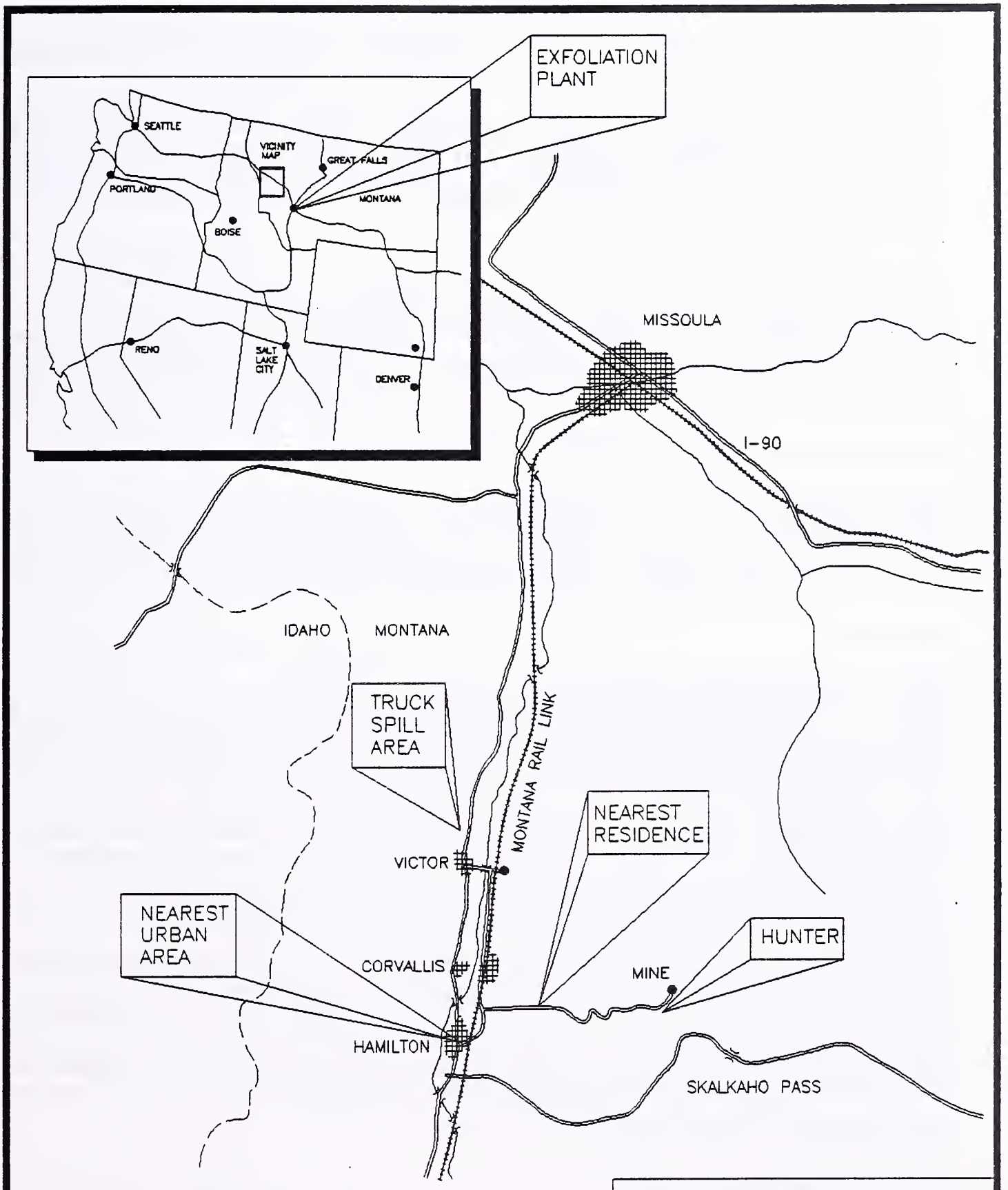
As a means of providing a conservative estimate, both models were executed irrespective of the receptor terrain. Both values are reported and the highest value of the two was chosen for health risk analysis.

RECEPTOR LOCATIONS

Both the ISC and Complex 1 models are capable of calculating the impacts for any number of emissions sources at any point located in space. The only variables required for the model are its spatial location relative to the center of the coordinate system, including the height of the terrain. The terrain height was determined by consulting the appropriate USGS map.

Since the primary purpose of the air dispersion modeling is to estimate ambient air fiber concentrations to characterize public health risks, several different types of receptor locations were chosen. The approximate location of the receptor points is shown on Figure 3.4-1.

Three primary target areas for the mine site and exfoliation plant impacts were identified. These areas included the nearest major population center, the nearest residence, and areas just outside of the plant property. The first areas are identified as Hamilton for the mine and concentrator activities, and Butte for the exfoliation plant. These represent the closest major population to the proposed activity.
The nearest residence to the mine site was selected as another area of interest. The location of the residence was confirmed on a USGS map. The nearest residence for the exfoliation plant appears to be



STANSBURY MINING EIS

HEALTH RISK EXPOSURE POINT LOCATIONS

CAMP DRESSER & McKEE INC.

CDM

FIGURE 3.4-1

the small community of Ramsey. An additional site (Nissler) was added to insure the area impact was identified. Again the location and elevation were confirmed with a USGS map.

The area near the mine site was also of interest since sportsmen and other recreationists are known to use the area for hunting and other recreational activities. Since the casual user of the area could be found in most any direction from the mine site, a set of 11 receptors were considered which surround the proposed facilities in all directions. The locations and elevations were identified with a USGS map and coded into the model input stream.

For the truck spill scenario, an array of downwind receptors was chosen to simulate a number of possibilities. The receptors were chosen beginning at a distance of 120 meters from the center of the spill (assumed to be highway) and extending to 4 kilometers. A total of 20 receptors distances were chosen. For purposes of this study, a flat terrain was assumed. This is a reasonable assumption since the spill scenario gave no effective plume rise to the emissions and thus peak impacts would be expected to occur at receptors near the ground.

EMISSION SOURCE CONFIGURATION

Previous sections have discussed how the emission estimates were calculated. The models, however, have various ways in which to treat these emission sources. The models are best at handling traditional stack emissions, but can process other sources using various techniques. The following provides a brief summary of how various emission sources were prepared for model execution.

ROAD DUST

Road dust is perhaps the most difficult source to prepare for model runs. The Complex 1 model has no options for its treatment except as a stack. To better simulate emissions from a road (as opposed to a stack), the simulated stack was give a large diameter (100 to 200 meters), a short stack height (7 meters to simulate the dust as it rolls off of the vehicle), a low exit velocity, and an ambient temperature exhaust.

Since the roads cover a number of miles, the road dust emissions were broken down into a series of stacks as noted above. The centers of these simulated stacks were placed between 100 and 200 meters from each other (depending upon the road in question). The stacks, thus, extended all the way from the concentrator to the disposal area and from the concentrator to the nearest paved road.

The ISC model, however, provides other options for treating road dust. The road dust was designated as a "volume" source rather than a stack. A volume source is a source of emissions that represents an area of emissions. This technique allows for a definition of the emissions "volume" and provides method of estimating initial dispersion parameters. Similar to the Complex 1 case, the road is treated as a series of emission points. Each point is placed along the road such that the entire road is included in the volume sources. A total of 55 sources were used to simulate both roads.

WIND EROSION, DUMPING, ETC.

These sources were handled in much the same way as described above. For Complex 1, the source was given a large stack diameter, small emission height, low exit velocity, and ambient temperatures. For ISC, most of these sources were treated as volume sources. A few of the sources (wind erosion, truck dumping, and soil removal) were treated as "area" sources. These sources are similar to volume sources except that the initial dispersion characteristics are slightly different.

CONCENTRATOR AND EXFOLIATION PLANT

With the exception of truck loading and unloading, the rest of these emission points were treated as a stack emission in both models. Specific stack exit velocities and stack heights were not available for each unit. A modest stack height and velocity was used in each case to provide a conservative estimate. Stack temperatures in the concentrator were assumed to be slightly above ambient. For the exfoliation plant, data from submitted blueprints were used for temperature estimation.

3.5 MODEL RESULTS

The modeling results can be broken down into three areas of interest; mine site boundary and nearby vicinity (including Hamilton), truck spills, and exfoliation plant (Butte). The parameter of interest produced by the air dispersion models is airborne concentration of amphibole fibers at specified locations of interest. The two air dispersion models used in this Health Risk Assessment (HRA) often provided different estimates of fiber concentrations. The results of both models are reported. The highest fiber concentration predicted by the two models was selected for health risk analysis.

The air dispersion modeling performed for this HRA provides several different estimates of amphibole fiber concentrations in air at the areas of interest. The peak 24 hour mean values provide an estimate of the highest short-term fiber concentrations in air. Since the mine would only operate primarily in the summer months, a three month mean average is also calculated. An annual average concentration is also calculated.

MINE SITE AND NEARBY VICINITY

In all cases, the mine site boundary has the highest predicted concentrations of airborne amphibole fibers, followed by the nearest residence and Hamilton (Table 3.5-1). The peak 24 hour mean value at the mine site boundary based on the Complex I model is 1.9×10^{-4} fibers/cc, which is within the range of asbestos fibers reported in outdoor air (2×10^{-5}). The peak 24 hour mean value is above the background range based on the ISC model. Peak 24 hour mean concentrations for the nearest residence and Hamilton are less than the mine boundary by approximately 10 to 1,000 fold. The ISC model always produced higher fiber concentration estimates than the Complex I model.

The predicted fiber concentration estimates for the three month mean and annual average follow a similar pattern as the peak 24 hour mean results. In both instances, the estimates are within or well below the reported outdoor range of asbestos fiber concentrations (0.00002-0.00075 fibers/cc; NAS, 1984).

TRUCK SPILL

Only the ISC model is used to estimate airborne fiber concentrations around a hypothetical truck spill. As shown in Table 3.5-2, the peak average concentrations of amphibole fibers are estimated to range from 2.9-8.8 x 10^{-4} fibers/cc. This range is similar to background levels reported for outdoor air.

EXFOLIATION PLANT

The maximum estimated amphibole fiber concentrations near the exfoliation plant are shown in Table 3.5-3. In all cases, predicated fiber concentrations are at least 100 times below concentrations typically reported for outdoor air.

TABLE 3.5-1

AMPHIBOLE FIBER ESTIMATES
FOR MINE SITE AND NEARBY VICINITY

	Complex 1 (Fibers/cc)	ISC (Fibers/cc)
Peak 24-Hour Mean		
Mine Site	1.9×10^{-4}	1.1×10^{-3}
Nearest Residence	2.3×10^{-6}	2.6×10^{-4}
Hamilton	4.9×10^{-7}	1.0×10^{-5}
May through October**		
Hamilton	4.0×10^{-8}	1.1×10^{-7}
Nearest Residence	1.8×10^{-7}	2.6×10^{-7}
Mine Site	2.7×10^{-5}	1.9×10^{-4}
Annual Average*		
Mine Site	1.4×10^{-8}	9.5×10^{-5}
Nearest Residence	9.0×10^{-8}	1.3×10^{-6}
Hamilton	2.0×10^{-8}	5.3×10^{-8}

* Calculated from 6-month means
** Calculated as the 6-month mean.

TABLE 3.5-2

TRUCK SPILL

	Complex 1 (Fibers/cc)	ISC (Fibers/cc)
1-Hour Average		
100 meters from accident	–	8.8×10^{-4}
24-Hour Average		
100 meters from accident	–	2.9×10^{-4}

TABLE 3.5-3

EXFOLIATION PLANT

	Complex 1 (Fibers/cc)	ISC (Fibers/cc)
Peak 24-Hour Mean		
Ramsey (nearest residence)	3.6×10^{-7}	4.7×10^{-7}
Nissler (nearby residence)	4.6×10^{-7}	2.8×10^{-7}
Butte	6.2×10^{-8}	1.4×10^{-7}
Annual Average		
Ramsey (nearest residence)	2.0×10^{-8}	1.9×10^{-8}
Nissler (nearby residence)	8.2×10^{-8}	4.0×10^{-8}
Butte	7.0×10^{-9}	4.7×10^{-9}

3.6 EXPOSURE SCENARIOS

The purpose of the HRA is to evaluate the potential health risks from development and operation of the Western Vermiculite Project mine. To adequately characterize a range of potential health risks from amphibole exposure related to mine operations, four general exposure situations are developed. These exposure scenarios differ in the length and intensity of exposure and include: 1) residential exposure some distance from the mine, 2) intermittent hunting near the mine, 3) residential exposure after a hypothetical truck spill, and 4) residential exposure near the proposed exfoliation plant. These exposure scenarios are discussed in more detail below (see Figure 3.4-1 for map). In all cases, the highest estimate of airborne fibers for the relevant exposure interval from the air modeling results is used as the exposure point concentration.

RESIDENTIAL EXPOSURE NEAR THE MINE SITE

Residential exposure to amphibole fibers from the mine site is evaluated at two locations; the nearest residence (about six miles away from the mine) and the nearest town (the City of Hamilton, 11 miles away). Twenty consecutive years of exposure are assumed. Exposure point concentrations is the annual average airborne fiber concentrations predicted by the air dispersion model results for each location.

HUNTING SCENARIOS

One type of potential exposure to amphibole fibers from the mine which is likely to occur is from recreational activities undertaken in the vicinity of the mine. Elk hunting is the most common recreational activity in this area and selected as representative of recreational-type exposure. Two types of scenarios were selected. A single, acute exposure scenario was developed which used the 24 hour average airborne fiber concentration near the mine as the exposure point concentration. A second, longer term hunter exposure scenario was developed which assumed 20 consecutive hunting trips to the mine area, each three days in duration, and used the 24 hour average airborne fiber concentrations as the exposure point concentration.

EXPOSURE FROM A HYPOTHETICAL TRUCK SPILL

Public concern has been raised regarding the potential exposure to airborne amphibole fibers released from concentrated ore during transport from the mine to the exfoliation plant in Butte. Since the trucks are to be covered with tightly-fitted canvas covers, exposure under normal conditions is likely nonexistent. However, it is possible that exposure could occur if a truck were to be involved in a traffic accident, in which the truck overturned and spilled the ore concentrate. To evaluate this exposure scenario, an air dispersion model was run to derive the set of meteorologic parameters along the haul route which maximized the airborne concentration of amphibole fibers. Concentration of the amphibole fibers in the ore concentrate is assumed to be 1.5×10^{-7} f/gram. A residence is assumed to be located within 100 meters of the spill and exposure duration is assumed to last for 24 hours.

RESIDENTIAL EXPOSURE NEAR THE EXFOLIATION PLANT

This exposure scenario is identical to residential exposure near the mine site, except that the exposure point concentration and distance from the fiber source are different.

Based on these assumptions and data, exposures were calculated for each of the exposure scenarios. The results of the exposure calculations are presented in Table 3.6-1. For the scenarios considered, the

TABLE 3.6-1

EXPOSURE ESTIMATES FOR SELECTED EXPOSURE SCENARIOS

Scenario	Exposure Point Concentration (fibers/cc)	Exposure Frequency (days/year)	Duration of Exposure (years)	Total Exposure (fibers-y/cc)
Residential - Hamilton	5.3×10^{-8} [a]	365	20	1.1×10^{-6}
Residential-Nearest Residence	1.3×10^{-6} [c]	365	20	2.6×10^{-5}
Hunting - One trip	1.1×10^{-3} [b]	0.3	1	9.0×10^{-7}
Hunting - Twenty, 3-day trips	1.9×10^{-4} [a]	3	20	3.1×10^{-5}
Truck Spill Accident	2.9×10^{-4} [b]	1	1	8.0×10^{-7}
Residential-Exfoliation Plant	8.2×10^{-8} [c]	365	20	1.6×10^{-6}

[a] 6-month mean
[b] Peak 24-hour mean
[c] Annual average

highest exposure is predicated for the long-term hunting exposure scenario, the lowest exposures are predicted for the two short-term exposure scenarios, one-time hunting and the accidental truck spill. These exposure estimates are combined in Chapter 5.0 with cancer potency factors derived in Chapter 4.0 to provide potential health risk estimates.

3.7 UNCERTAINTIES RELATED TO EXPOSURE ASSESSMENT

There are many potential sources of uncertainty in an exposure assessment when actual contaminant concentrations at the point of exposure are not available. The main sources of uncertainty in the present exposure assessment are derivation of the number of amphibole fibers present in the ore, assumptions regarding fiber emission rates, and dispersion modeling of amphibole fibers into the environment. These uncertainties are discussed more fully in the sections below.

Amphibole fiber content of the vermiculite ore from the ABM Ridge deposit was estimated by the RJ Lee (1988a) in terms of volume percent of the ore that is comprised of amphibole fibers but did not estimate the number of fibers per unit of ore. A range of estimates for this number were developed based on different assumptions regarding weight and volume of the amphibole fibers. These estimates ranged over 3 orders of magnitude. To ensure that health risks were not underestimated, a relatively high estimate of amphibole fibers per unit of ore was selected for use in risk assessment, but the actual number could be considerably lower.

Another key assumption of the exposure assessment is that the number of fibers detected during the ore analyses would be released into the environment by mining and handling. It is important to realize that the ore samples analyzed by RJ Lee were extensively crushed and ground prior to evaluation and that the fiber counts from these samples represent the maximum number of fibers present in the rock. Since the actinolite and hornblende are primarily located in waste rock which will be either avoided or separated from the vermiculite ore, it is likely that the vast majority of amphibole fibers will remain locked in the waste rock, rather than released into the air. As a result, the rate of fiber release from various mine-related activities is probably considerably overestimated.

Exposure duration for the long-term exposure scenarios assumed 20 years of exposure. The operating life of the mine is estimated to be 5-8 years. The exposure estimates are therefore 50-75 percent too high.

There are a number of uncertainties related to the air dispersion modeling and the data used to perform the modeling. All possible assumptions used in the air dispersion modeling have not been identified. The assumptions presented are deemed the most important variables. Other assumptions were not presented either because the affect of an alternative option is not known or believed to be minimal. The estimate of amphibole fiber emissions from road dust may be far too high. It was assumed that rock used on the entire road contained amphibole fibers in the same concentration as found in the ore body. It is more likely that the actual road dust emissions will contain fewer amphibole fibers due to a different grade of road building material. The assumption is especially noteworthy since the road dust emissions account for about 50 percent or more of the predicted impact near the mine site. It is a much larger percentage of the predicted impact on the nearest residence and Hamilton.

The choice of Spokane, Great Falls and Missoula (as previously described) for some meteorological parameters should have only a minor impact on modeled output. Since the primary variables (wind speed and direction) are representative of the areas in question, the impact is likely to be small. The on-site data at the mine was only available for the months of June, July, and August. It would have been

preferable to use data which encompassed the complete period in which the mine is expected to operate (May through September or October). Additional data in September would probably indicate somewhat lower wind speeds and more periods of stable air. This would tend to yield higher impacts. On the other hand, May is considered a relatively windy month with excellent ventilation. This would tend to reduce the predicted impacts.

The results of the laboratory analyses of exfoliated samples indicates that none of the samples contained any amphibole fibers. Nonetheless, it was assumed that 15 million fibers per gram of airborne particulate would be emitted.

The air dispersion models that were selected are approved by EPA models for regulatory purposes. By design, they tend to over-predict airborne concentrations of pollutants. This tendency is not absolute, however, since examples can be found in which the models have under-predicted actual air quality impacts. Nevertheless, it is the prevailing opinion that these models will usually tend to over-estimate observed results. The consistent selection of the highest model results for each exposure scenario will also provide a bias towards overestimation of potential health risks.

3.8 SUMMARY

Offsite dispersion of airborne fibers is the major exposure pathway for this risk assessment and the only pathway which will be selected for quantitative evaluation. Inhalation is the primary route of exposure. Exposure scenarios considered for this risk assessment are residential and recreational exposures from different mine-related activities, including mining, transportation, and exfoliation. Exposure point concentrations are developed using estimates of amphibole fibers/gram of ore, dust-emission factors for various mining and processing activities, and air dispersion modeling results. Exposure point concentration estimates range from 1.1×10^{-3} fibers/cc near the mine site to 8.2×10^{-8} fibers/cc near the exfoliation plant in Butte. Exposure estimates for selected exposure scenarios range from 8×10^{-7} fibers-y/cc to 3.1×10^{-5} fibers-y/cc; with the exception of the peak 24-hour mean concentration estimate for the mine site, the predicted fiber concentrations are either slightly above or well below background outdoor concentrations in air from other parts of the country. These estimates are used in Chapter 5.0 to characterize potential excess cancer risks for the exposure scenarios which were selected for evaluation.

4.0 TOXICITY ASSESSMENT

In this section, the adverse biological effects from exposure to asbestos and other amphibole minerals are discussed. Data from experimental animal and human studies are summarized. Based on these data, relevant cancer endpoints for the risk assessment are identified. Dose-response relationships are evaluated to select the most appropriate measures and risk assessment models to quantify cancer health risks from asbestos. Uncertainties related to the toxicity information are also discussed.

4.1 TOXICOLOGY OF ASBESTOS

Based on the exposure assessment described in Chapter 2.0, exposures are likely to be extremely low in comparison to any exposures that have demonstrably caused disease. The focus of the toxicity assessment is therefore placed on toxic effects possibly associated with low exposures to airborne asbestos, namely cancer. Other health effects that are likely to be associated only with high exposure to asbestos, in particular asbestosis, are not relevant in this situation.

The discussion of experimental animal and epidemiologic studies presented in this section is not intended to be exhaustive. Rather, a representative summary of those studies, especially mining epidemiologic studies, is given using those which are relevant to the estimation of potential cancer risks from the Western Vermiculite Project. Of particular interest are those studies which deal with the tremolite-actinolite group. For the interested reader, there are several comprehensive reviews of the asbestos toxicology literature available, including *Asbestiform Fibers: Nonoccupational Health Risks* (NAS, 1984), and *Non-Occupational Exposure to Mineral Fibers* (IARC, 1989).

EXPERIMENTAL ANIMAL STUDIES

In the case of asbestos, animal studies serve only a supporting role in establishing asbestos etiology since epidemiologic information is sufficient to establish asbestos-disease causality in humans. Generally, the animal data are consistent with and confirm the epidemiological information. The advantage of animal work is that precise exposure controls and doses can be established and results can be more accurately determined. The two major disadvantages of animal studies are: 1) differences in genetics, biology, and physiology between man and the animal model; and 2) requirement for extrapolation to low doses to calculate risk. Animal studies of interest include intrapleural injection or intratracheal injection (non-physiological methods) and inhalation routes. The primary animal model has been the rat.

It is certain that there are differences between rats and humans in the manner in which each deals with asbestos. For example, rats, as opposed to humans, do not form asbestos bodies. (Asbestos bodies are asbestos particles coated with protein and deposited in lung tissue. In general, proteinaceous coated bodies in the lung are referred to as ferruginous bodies.) Also with rats, chrysotile is equal to or more potent than some amphiboles in causing tumors in the rat which appears the reverse of the human situation (Walton, 1982). The importance of these and other differences is not known.

Animal studies indicate tremolite with high aspect ratio fibers is a more powerful mesothelioma carcinogen than tremolite with short, low aspect ratio fibers (Wagner, 1982). Evidence from injection studies in rats have demonstrated that the more potent fibers for causing mesothelioma sarcomas are those greater than 8 microns in length and less than 0.25 microns in diameter (Davis, 1986). Long term inhalation studies using amosite and chrysotile short fiber preparations demonstrated that the fibrosis and generation of tumors were roughly in proportion to the number of lung fibers present.

SELECTED EPIDEMIOLOGY OF ASBESTOS

Formal studies of human populations and the diseases that occur after exposure to two or more levels of some risk factor are referred to as epidemiologic studies. Data from reported epidemiologic studies can be reviewed to qualitatively evaluate the possible health effects associated with the proposed Stansbury mine. In this case, none of the studies is exactly comparable.

The principal cancers associated with exposure to asbestos are mesothelioma and lung cancer. McDonald and McDonald studied the environmental epidemiology of mesothelioma in the United States and Canada and report for the year 1972 that Montana was among the states with the highest rates (2.9 cases per million population) similar to Wyoming (3.1 per million), whereas, the neighboring states of Idaho, North Dakota, and South Dakota reported no cases (McDonald, 1977). Since this is based on only two cases in Montana and one in Wyoming, the small number of cases precludes any firm conclusions from these observations. Environmental exposure to asbestos has reportedly not been demonstrated to cause an increase in the mortality for mesothelioma in women. This may indicate that the risk for mesothelioma from nonoccupational asbestos fiber exposure is small (Davis, 1988) or that too few women have yet been studied.

Few epidemiologic studies have been reported dealing with environmental conditions (outside of the workplace) which is the focus of this health risk assessment. One example is in Turkey where an enormous relative risk (about 90 times the usual rate) for mesothelioma has resulted from exposure to zeolite fibers (which are physically similar but do not have the chemical composition of asbestos — Baris, 1987). Baris (1988) also has found increased mesothelioma in Turkey where asbestiform tremolite has been found as an environmental contaminant. Other populations in Turkey, and Greece have substantial incidence of mesothelioma, presumably due to the environment presence of very long fibers (aspect ratio $>$ 50) (Yaziogliu, et al. 1980, Langer and Nolan, 1987).

As indicated earlier in this report, the significant amphibole material in the ore of the Stansbury mine is actinolite (probably non-fibrous) and hornblende (non-fibrous). No epidemiologic studies have been reported on these specific materials. However, the closest comparison can be made with mines contaminated with actinolite-tremolite. The mineralogic distinction between tremolite asbestos and actinolite asbestos is based on iron content. Mineralogically, tremolite is present when the atomic proportion of magnesium/(magnesium plus iron) is greater than 0.90 indicating a near absence of iron while actinolite has a greater than 10 percent iron content. From a health perspective, there are no studies which justify assuming differences in health effects based on percentage of iron content; tremolite asbestos and actinolite asbestos can be considered as equivalent. Hornblende is a form of amphibole that has never been found in the fibrous form and no health related effects of hornblende have ever been reported.

EPIDEMIOLOGIC STUDIES OF MINES

Libby Mine

The epidemiological studies most relevant to the Stansbury mine are those of the Libby, Montana vermiculite mines which are contaminated with tremolite asbestos (referred to as actinolite-tremolite in some reports). The presence of asbestos in the vermiculite deposit at Libby has been recognized since 1942, when impinger samples were taken by a U.S. Public Health Service Officer assigned to the State of Montana. All samples taken by the State of Montana prior to 1969 were by the impinger method. The first samples by the membrane filter method were taken by the field studies unit of NIOSH in 1967.

As noted in Amandus, et al. (1987), concentrations averaged over 60 fibers per cc of air in the dry mill area. Of 599 fibers viewed by phase contrast microscopy, only one was thicker than 2.49 microns, and 90 percent had an aspect ratio greater than 10. Not only are fibers thicker than 3 microns unlikely to be respirable, but these data indicate that they are virtually absent in the dust of vermiculite mining. This provides additional support for considering only fibers thinner than 3 microns in the Health Risk Assessment (Chapter 3.2). It should be noted that the counts in the Libby mine were much reduced over the years, with the highest average reported by Amandus, et al. in 1980-1982 being only 1.2 f/cc.

McDonald et al. (1986) investigated a cohort of 406 men employed before 1963 who worked at least one year in the Libby, Montana mine of WR Grace & Company. The mining process involved a dry screen methodology which was said to be very dusty prior to 1965 but became much cleaner when ventilation equipment was installed. In 1974 both the dry and wet mills were shut down and a new mill began operation nearby. The ore was said to be "contaminated with fibrous amphibole deposits in the tremolite series." Compared to US white males, the cohort exhibited excess mortality from respiratory cancer (Standardized Mortality Ratio (SMR) = 2.45), non-malignant respiratory disease (SMR = 2.55), and accidents (SMR = 2.14). In addition, four deaths were from mesothelioma, which is well above the expected. In a different paper on the same vermiculite mine, McDonald et al. (1986) report on a radiologic survey. They studied 173 current and 110 past employees. "Logistic regression analyses showed independent effects of age, smoking, and exposure on the prevalence of small opacities and of age and probably of exposure on pleural thickening." The regressions suggest that the increase in prevalence of small parenchymal opacities by retirement is between 5 and 10 percent per 100 fiber/ml years. The authors also conclude that at 0.1 fiber/ml, the reported current exposure level, "no excess of radiological change should be detectable after a working life of 40 years."

The same Libby, Montana mine reported on by McDonald et al. (1986) was also studied by Amandus and Wheeler (1987). The study group was larger in the Amandus study than in the McDonald study. Based on their study of 575 men hired prior to 1970 and employed at least 1 year, they state that the "mortality from nonmalignant respiratory disease (NMRD) and lung cancer was significantly increased compared to the U.S. white male population." They also noted that there were more small opacities on radiographic test than expected (Amandus, et. al, 1987). Amandus added an additional comment to the report when he stated in a letter to the editor (1987) that the slope of the prevalence of radiographic opacities by cumulative exposure (MPPCF-years) was steeper for the Libby work force than for three other asbestos exposed groups that had been reported in the literature. The exposure estimates are presented in a separate paper (Amandus, et al, 1987) which discusses the exposure to the tremolite-actinolite contaminant. The radiological findings are given in the final paper of the series (Amandus, et al, 1987) which notes that "the prevalence of small opacities was significantly greater for vermiculite workers with greater than 100 fiber/ml-years exposure than for comparison groups."

Canadian Mines and Environment

Epidemiologic studies of people living in the chrysotile mining towns of Eastern Quebec, with ambient levels 250 to 500 times that of most North American cities, have not demonstrated an excess respiratory disease incidence (Churg, 1986). The asbestos content of lungs of seven long term residents of the Thetford Mines, Quebec, who had never been employed in the chrysotile mining and milling industry were analyzed. Mean tremolite content was 5.3 million fibers/gram dried lung in comparison to 0.4 million/gram for Vancouver residents and 218 million/gram for chrysotile miners. Those residents living in the mine environment had a ten-fold higher fiber content in their lungs in comparison to Vancouver (background town with no asbestos mining activity) residents, but had a substantially lower lung fiber content than the chrysotile miners. Ambient airborne chrysotile asbestos concentrations reported in

Thetford Mines were estimated to be 250 to 500 times higher than that of most North American cities. The proportion of tremolite in the asbestos dust in the Quebec mines is reported to be less than 1 percent (Davis, 1988). Recently, Case et al (1990) reported on an increase in the number of cases of mesothelioma coming to autopsy in the region (18 occupational, 1 wife of a miller). In this study, multivariate analysis using lung content of amphibole fibers vs controls and adjusted for chrysotile was statistically significant ($p < .001$).

South African Vermiculite Mines

South African vermiculite most likely is contaminated with an amphibole asbestos representing non-fibrous tremolite-actinolite and anthophyllite. Fiber levels measured in 1987 were 0.27 to 0.80 fibers per cc. Up to 0.4 percent amphibole contamination has been previously found in South African ore. Ferruginous bodies (protein coated deposits) were found in two out of three sets of respiratory organs of men who died and were previously employed at the South African vermiculite mine. Fibers found in the lung were crocidolite, which were felt to be from an asbestos field near the vermiculite mine where crocidolite and amosite were mined (Hessel, 1989). The authors conducted a cross sectional study of radiological findings and lung function in 172 Black South African vermiculite workers compared to other workers in the same operation who were not exposed to vermiculite. The average length of employment in the groups was 9 to 15 years and the average age was 39 to 43; consequently it is possible that insufficient time had elapsed for any health effects to become apparent. Nevertheless, "only two of the vermiculite workers showed evidence of small opacities of 1/0 or more (according to the ILO 1980 classification); lung function was comparable with the other groups of workers, and there was no excess of respiratory symptoms among the vermiculite workers." This group is of particular interest because the exposure to vermiculite and dust appears to be at about the same level as at the vermiculite mine in Libby Montana, although the amphibole content is only 0.4 percent compared to up to 2 percent at Libby.

South Carolina Mines

McDonald et al. (1988) reported on the health effects observed in 194 men who worked in vermiculite mining and milling in South Carolina. The fibrous tremolite exposure was much lower in this small cohort (mean 0.75 f/cc y) than in the Montana cohort (mean 144.6 f/cc y). The SMR for lung cancer was 1.21 reflecting 4 deaths when 3.31 were expected. No death was attributed to mesothelioma or pneumoconiosis. The authors conclude, "Any possible adverse effects of work with vermiculite, minimally contaminated with fibrous or non-fibrous tremolite, were thus beyond the limits of detection in this work force."

SUMMARY:

The epidemiologic studies demonstrate the following points:

- Mesothelioma and lung cancer in an occupational mine setting due to fibrous tremolite-actinolite exposure have been clearly demonstrated.

- Studies of health effects resulting from non-fibrous actinolite or hornblende for either occupational or environmental exposure are unknown.

- In the epidemiologic studies the major influence is dose (number of appropriately sized particles which are inspired) but other factors such as cohort size, length of follow-up, age of subjects, etc. influence whether the study is definitive.

- A symptomatic fiber concentration in the lungs can be used as a marker of the exposure and liklihood of disease.

4.2 CANCERS OF CONCERN

The principal cancers associated with exposure to asbestos are lung cancer and mesothelioma. In addition, there are some indications that cancers at other sites, such as larynx, pharynx, and gastrointestinal tract, are related to asbestos exposure. However, the evidence for these additional sites being affected is inconsistent, with many studies not indicating increases at these sites. Moreover, even if these sites are affected by asbestos, including them in a risk assessment would add only minimally to the risk from lung cancer and mesothelioma. For example, the study of insulation workers by Selikoff et al. (1979) presents perhaps the strongest evidence that cancers other than lung cancer or mesothelioma might result from asbestos exposure. However, even in this study the excess deaths attributable in total to the esophagus, stomach, larynx, pharynx, kidney, colon and rectum are only 12 percent of excess cancers attributable to lung cancer and mesothelioma. Estimates of risk from lung cancer and mesothelioma are unlikely to be accurate to within 12 percent. Thus, even if risks from these other types of cancer were real and could be accurately quantified, such quantification would not meaningfully improve the accuracy of the assessment.

Three federal regulatory agencies (CPSC, 1983; OSHA, 1983; EPA, 1986) have used essentially the same approach to assessing the risk from exposure to asbestos. In this approach, separate models are used for lung cancer and mesothelioma and results of the two models are combined to obtain an estimate of total risk. The most important feature of these models is the shape of the dose response curve used to extrapolate to low doses risks observed in epidemiological studies involving much higher doses. Linear dose response models are assumed for both lung cancer and mesothelioma. This means that it is being assumed that there is no exposure that is completely without risk (i.e., no "threshold" of exposure) and that the additional risk resulting from a small amount of exposure is simply proportional to the amount of exposure. Although a linear dose response is consistent with some theoretical hypotheses and with limited epidemiological dose response data, it has not been verified directly to hold at very low levels of exposure, nor has the existence of a threshold of exposure below which there is no risk been ruled out experimentally. It is generally considered unlikely that a linear dose response underestimates the risk and it could possibly overestimate risk. For example, regarding the use of a linear dose response for asbestos, the EPA (1986) stated: "Use of a linear dose response relationship for lung cancer and mesothelioma is likely to be a conservative extrapolation procedure (i.e., overestimate risk) from the point of view of human health."

4.3 DETERMINATION OF ASBESTOS CANCER POTENCIES

The models used for estimation of lung cancer and mesothelioma risks are those recommended by USEPA (1986).

Both these models require as input an estimate obtained from epidemiological data of the potency of asbestos for causing the effect. EPA (1986) employed a potency of 0.01 $(\text{f-y/cc})^{-1}$ (fiber-years per cubic centimeter) for lung cancer and 1.0×10^{-8} $(\text{f-y/cc})^{-1}$ for mesothelioma. A wide range of potency estimates have been obtained from different epidemiological studies. Table 4.3-1 presents a summary of potencies obtained from studies in which exposure was primarily to a single fiber type. The values used by the EPA are within the range of potencies listed in this table.

TABLE 4.3-1

CANCER POTENCY DATA FROM EPIDEMIOLOGICAL STUDIES OF POPULATIONS EXPOSED TO A SINGLE TYPE OF ASBESTOS

Fiber Type	Type of Operation	Lung Cancer			Mesothelioma			Reference
		Total Cases	Excess Cases	Potency $(f\text{-}y/cc)^{-1}$	Total Cases	% Excess Lung Cancer	Potency $(f\text{-}y/cc)^{-1}$ $X10^8$	
Chrysotile	Textile	59	29	0.025	1	3	0.05	McDonald et al. 1983
Crocidolite	Mining	91	34-57	0.18	32	56-94	8.0	Armstrong et al. 1988
Chrysotile	Friction Man.	73	24	0.00010	0	0		McDonald et al. 1983
Chrysotile	Mining	230	45	0.0006	10[a]	22		McDonald et al. 1980
Amosite	Manufacturing	111	90	0.043	17	19	3.2	Seidman et al. 1986
Amosite	Manufacturing	57	28		4	14		Acheson et al. 1984
Tremolite	Vermiculite Mining	23	14	0.01	4	29		McDonald et al. 1986

[a]Some of these deaths may be attributable to crocidolite exposure.

Potency estimates for lung cancer and mesothelioma, such as those that appear in Table 4.3-1, cannot be compared to each other owing to the fact that the lung cancer and mesothelioma models are different. In fact, despite the large numerical difference in the potencies, the estimated risks of lung cancer and mesothelioma typically are of the same order of magnitude.

The reasons for wide range in potencies for asbestos shown in Table 4.3-1 are not fully understood. They may be due partially to differences in techniques used to measure asbestos. They may also be due to differences in fiber characteristics in the different environments. It is generally felt that longer and perhaps thinner fibers are more risky, and the percentage of fibers having these characteristics varies in different environments. For example, asbestos used in textile operations likely contains a higher percentage of longer and thinner fibers than asbestos to which miners are exposed. There is also considerable evidence that amphibole asbestos poses a higher risk of mesothelioma than chrysotile. Whatever the reasons for the different potency estimates, their existence suggests that more accurate estimates of risk can be obtained by taking into account the fiber types and fiber dimensions particular to the setting for which risk estimates are required.

The exposure setting most like that envisioned for the Stansbury mine, and for which epidemiological data are presently available, may be the vermiculite mine near Libby, Montana. This setting involved mining of vermiculite in an area of Montana relatively near the Stansbury site. Thus, both the Libby and Stansbury sites involve vermiculite mining and the socioeconomic characteristics of the workers are likely to be similar as well.

Asbestos in the tremolite-actinolite series is found at the Libby mine, whereas actinolite and hornblende, but no tremolite, have been found at the Stansbury site. Tremolite and actinolite are distinguished by the presence of calcium and the two minerals are very similar chemically. Actinolite contains both iron and magnesium, whereas tremolite contains magnesium, but very little iron.

Two epidemiological studies have been conducted of workers at the Libby mine (McDonald et al., 1986 and Amandus and Wheeler, 1987), and results of the two studies are similar. McDonald et al. estimated a lung cancer potency for tremolite of between 0.007 and 0.013 $(\text{f-y/cc})^{-1}$, whereas Amandus et al. estimated a potency of 0.006 $(\text{f-y/cc})^{-1}$. These potency estimates are also very close to the lung cancer potency estimate for asbestos of 0.01 $(\text{f-y/cc})^{-1}$ used by EPA. Consequently, 0.01 $(\text{f-y/cc})^{-1}$ will be used as the lung cancer potency in this assessment.

One difference that may exist between Libby and the Stansbury site is that some of the tremolite at Libby is fibrous, whereas there is some question as to whether any of the acinolite at the Stansbury site is in the fibrous form (see USFS/DSL, 1988). As discussed previously, it is also unclear whether non-fibrous amphibole minerals (i.e., cleavage fragments) pose any risk of cancer. This suggests that use of the Libby data may overestimate any cancer risk that may exist at the Stansbury site.

Although McDonald et al. (1986) reported four mesotheliomas among 163 deaths in the Libby cohort, they did not present the data in a form so that it could be used to estimate a potency for mesothelioma directly. Consequently, the potency for mesothelioma will be estimated indirectly by comparison with potency estimates obtained from other epidemiological studies involving exposure to amphibole. Studies involving chrysotile exposures will not be considered because of the considerable data indicating that chrysotile is not as potent as amphiboles in causing mesothelioma.

There are only two epidemiological studies of populations exposed to amphiboles exclusively for which data are available for estimating potencies for both lung cancer and mesothelioma. These are the Seidman

et al. (1986) study of workers employed in the manufacture of amosite insulation products during World War II, and the Armstrong et al. (1988) study of Australian crocidolite miners. In the former study, the ratio of the mesothelioma potency to lung cancer potency is 7.4×10^{-7} (EPA, 1986), and in the latter study this ratio is 8×10^{-7} (Crump, 1990), which is excellent agreement. Assuming the latter ratio also holds for actinolite, and assuming a lung cancer potency of 0.01 $(f\text{-}y/cc)^{-1}$ for actinolite, the mesothelioma potency is 8×10^{-9} $(f\text{-}y/cc)^{-1}$ for actinolite.

This calculation does not make use of the observed number of mesotheliomas in the Libby cohort. Further, it assumes that the ratio of the mesothelioma potency to the lung cancer potency is the same in all amphiboles. This assumption may not be accurate, as some researchers believe that the fiber size fractions that are most potent in the development of mesothelioma are different from those that are most potency in lung cancer (e.g., Lippmann, 1988). Thus, it may be useful to make a slightly more detailed calculation that utilizes the mesothelioma data from the Libby cohort.

The potency for lung cancer obtained from the Libby cohort is 0.01 $(f\text{-}y/cc)^{-1}$, whereas the corresponding potency obtained from amosite manufacturing is 0.043 $(f\text{-}y/cc)^{-1}$. This suggests that, relative to amosite in manufacturing, tremolite-actinolite is about one-fourth as potent in causing lung cancer. However, in this study, there were four mesotheliomas total, and fourteen lung cancers in excess over that predicted by standard rates (ratio of 4/14 = 0.29), whereas in amosite manufacturing there were 17 mesotheliomas, and 90 excess lung cancers (ratio of 17/90 = 0.19). Thus, these data suggest that tremolite-actinolite may be somewhat more potent than amosite in causing mesothelioma relative to its potency for causing lung cancer. This information can be incorporated in estimating a potency for mesothelioma from actinolite exposure by multiplying the mesothelioma potency for amosite-induced mesothelioma times the ratio of the lung cancer potencies for actinolite and amosite times the tremolite-actinolite/amosite ratio of the mesothelioma/lung cancer ratios. This yields a mesothelioma potency of

$$(3.2 \times 10^{-8})(.01/.043)(0.29/0.19) = 1.1 \times 10^{-8} \ (f\text{-}y/cc)^{-1}.$$

The first multiplicative ratio accounts for differences in the potencies of amosite and actinolite as indicated by the differences in lung cancer potency, and the second factor account for differences in the mesothelioma potency for the two types of fibers that is over and above the differences expressed by differences in lung cancer potency. A somewhat smaller potency would be obtained if this procedure is applied to the Armstrong et al. data on crocidolite miners. However, the results based on the amosite data will be used in this assessment as a conservative measure.

The value of 1.1×10^{-8} is very close to the overall mesothelioma potency of 1.0×10^{-8} used by EPA for all fiber types. Since the EPA estimate is currently in standard use and there is no evidence from this analysis that estimate is in serious error if applied to actinolite, the value of 1.0×10^{-8} will be used as the potency for mesothelioma in this assessment.

4.4 SUSCEPTIBLE POPULATION SUBGROUPS

Children and smokers are two population sub-groups which may exhibit enhanced susceptibility to the carcinogenic risks of asbestos. Children may be at greater risk of developing cancer simply because of the durability and persistence of asbestos fibers in the lung and the long latency period of asbestos-induced cancer, especially mesothelioma. An exposure scenario for residential exposure from birth to age 20 is used to evaluate the difference in risk for this group compared to risks for adult exposure for each residential exposure scenario. Results from numerous epidemiological studies indicate that the increased risk of lung cancer from occupational exposure to asbestos is greater among smokers than

nonsmokers. For this reason, cancer risks from amphibole exposure related to the Western Vermiculite Project are calculated separately for smokers and nonsmokers.

4.5 SUMMARY

There is no toxicology information available which specifically addresses the potential adverse health effects from exposure to nonasbestiform actinolite and hornblende. For the purposes of this HRA, these minerals are assumed to have the same health risk potential as asbestos. At the low exposures predicted to occur in the areas of interest for this site, mesothelioma and lung cancer are the relevant toxicity endpoints. Epidemiology of residential exposure from mines containing asbestos indicates equivocal results regarding excess cancer risks. Evaluation of asbestos occupational studies provided cancer potency factors very near those currently recommended and used by EPA. The EPA potency factors were selected for this HRA.

5.0 RISK CHARACTERIZATION

Estimates of offsite airborne concentrations of asbestos fibers that are projected to occur from the Stansbury mine operation (Tables 3.5-2 and 3.5-3) are generally much smaller than levels that have been shown to cause any disease. The average level of 5.3×10^{-8} f/cc projected for Hamilton is more than 1,000,000 times smaller than the current OSHA standard for the workplace. There is no scientific evidence to indicate that such low levels pose any risk of disease.

However, it is scientifically impossible to prove that low levels such as these cannot cause any disease. As a means of dealing with this uncertainty, it is possible to project risks that might occur, based on disease levels measured in occupational cohorts at high exposures, and using a theoretical dose response model to extrapolate risks measured at high exposure levels to lower doses. Federal agencies routinely use such models to help in making regulatory decisions, and asbestos is among the many chemicals to which they have been applied.

5.1 RISK ASSESSMENT METHODOLOGY

In this chapter, the exposure estimates for selected exposure scenarios are combined with cancer potency factors to estimate excess cancer risks related to operation of the Western Vermiculite Project mine. Cancer risks for both lung cancer and mesothelioma are calculated for exposure scenarios using 4 types exposure situations. These risks are calculated separately for smokers and nonsmokers. The effect of age of exposure to asbestos on cancer risk is also evaluated. The excess cancer risks are discussed and uncertainties associated with the risk estimates are described.

5.2 CANCER RISK ESTIMATES

Table 5.1-1 summarizes excess cancer risk estimates calculated for seven different exposure scenarios. The risk estimates are expressed as potential excess cancer cases per million persons exposed for the specified interval. For example, the risk to a non-smoker exposed for 20 years at levels estimated for Hamilton is 0.012 per million or 1.2 per 100 million. This means that if 100 million persons (about 40 percent of the population of the U.S.) were exposed to this level, one cancer would be expected as a result of the exposure, compared to about 30 million total cancers that are expected to occur anyway in this population.

As indicated in Table 5.1-1, the maximum excess cancer risks calculated for any exposure scenarios considered in this EIS for the Western Vermiculite Project is 0.19 per million for a smoker who participates in twenty consecutive 3-day hunting trips in the vicinity of the mine over 20 years. The next highest risk estimate, 0.14 per million, is associated with residential exposure for a smoker who lives nearest the mine and who is exposed to asbestos emissions from the mine for 20 years beginning from birth. Maximum excess cancer risk estimates for Hamilton are 0.012 per million for a smoker exposed to asbestos from birth. Risks from other exposure scenarios range from 0.13 per million to 0.0003 per million.

Based on the results of the health risk assessment, the likelihood of adverse health effects from asbestos exposure are expected to be extremely remote.

Since there is evidence that asbestos exposure and cigarette smoking act in a multiplicative fashion in causing lung cancer and the risk assessment model used for lung cancer assumes such a relationship, risks are presented separately for smokers and non-smokers. Although smoking is not known to affect

TABLE 5.1-1

ESTIMATED RISK OF CANCER FROM OFFSITE EXPOSURE
(per million persons exposed)

	Non-Smoker			Smoker		
Exposure Scenarios	Lung Cancer	Mesothelioma	Total[a]	Lung Cancer	Mesothelioma	Total
20 years of continuous exposure in Hamilton beginning at birth	0.0003	0.012	0.012	0.003	0.009	0.012
20 years of continuous exposure in Hamilton beginning at age 20	0.0004	0.004	0.004	0.003	0.003	0.006
20 years of continuous exposure at the nearest residence beginning at birth	0.009	0.063	0.072	0.084	0.057	0.14
20 years of exposure - 3 days hunting/year	0.011	0.12	0.13	0.10	0.085	0.19
One-time exposure on hunting trip to 24 hour maximum levels	0.0003	0.006	0.006	0.003	0.004	0.008
Exposure 120 meters from truck spill accident	0.0002	0.007	0.008	0.002	0.006	0.008
20 years exposure at nearest residence to exfoliation plant	0.0005	0.018	0.019	0.005	0.014	0.019

[a] In some case total risk estimates differ from specific risks calculated individually for lung cancer and mesothelioma due to rounding.

mortality rates for mesothelioma, smoking does affect lifespan and consequently affects the lifetime risk of mesothelioma. This explains why risk of mesothelioma is lower in smokers. Many smokers don't live long enough to be at substantial risk of mesothelioma.

5.3 DISCUSSION

One way to put the risks in Table 5.1-1 in perspective is to compare them to other risks. If a linear dose response is applied to tobacco smoke in the same way that a linear model was used to estimate the asbestos-related risks appearing in Table 5.1-1, the estimated risk of lung cancer from smoking a single cigarette is on the order of one in a million (EPA, 1986b). Thus, the predicted risk for each of the scenarios is far less than the risk predicted to result from smoking a single cigarette in one's entire lifetime.

At an altitude of 7,000 feet (the approximate elevation of the Stansbury mine site), exposure to cosmic radiation is about 63 millirem (mrem) per year (NRC, 1980), or 0.17 mrem per day. The risk of skin cancer from exposure for one day at this level, based on a linear dose response model, is 0.14 per million as projected by the National Academy Sciences Committee on the Biological Effects of Ionizing Radiation (NRC, 1989). This risk is 10 times greater than the estimated risk in Hamilton from exposure to asbestos from the Stansbury mine for 20 years.

Based on 1988 highway statistics for Montana (Accident Facts, 1989), the risk of cancer from continuous exposure for 20 years in Hamilton to asbestos from the Stansbury mine (0.012 per million) is equal to the risk of being killed while riding five miles in an automobile on Montana highways.

The Committee on Nonoccupational Health Risks of Asbestiform structures of the National Research Council (1984) considered 0.0004 f/cc to be the approximate average level of structures that the general public might encounter. This level is 8000 times higher than the average level in Hamilton that is projected to result from the Stansbury mine. Thus, exposures from the mine are not expected to contribute substantially to existing background exposure levels.

5.4 UNCERTAINTIES

There are many uncertainties in the estimates presented in Table 5.1-1. However these uncertainties are generally of a nature that suggests that the risks may be less than those presented in Table 5.1-1.

The vast majority (perhaps all) of the amphibole structures found at Stansbury are not asbestiform but consist of cleavage fragments. These structures were considered to be as potent as true asbestos structures, despite the lack of confirmation of this and the judgement of some researchers that cleavage fragments pose less risk (possibly zero risk) than true asbestos structures.

The majority of amphibole found at the Stansbury site is hornblende (89 percent based on total mass of federal fibers -- RJ Lee Table II), which does not occur in a fibrous form, and which has not been implicated as a cause of cancer in human populations. Nevertheless, as a conservative measure, hornblende was included in exposure estimates. The estimate of the ore fiber concentration (number of fibers per gram of ore) used in the air modelling (3×10^7 f/g) is three times larger than the representative value obtained by including all respirable amphibole structures, including hornblende, with a greater than 3:1 aspect ratio. The corresponding ore concentration based on actinolite only is 1/100 as large as the concentration assumed in the air modeling. Even with a highly conservative estimate of the average weight of an actinolite fiber (assuming the average weight is that of a fiber five microns long

and 0.3 microns in diameter), the estimated concentration is still less than that assumed in the modelling. If both a highly conservative estimate of the average fiber weight is used and hornblende is also included, the estimated ore concentration is ten-fold higher than that used in the air modelling. Even with this highly conservative approach the estimates of risk at Hamilton would be only one in ten million. A linear dose response model was assumed for both lung cancer and mesothelioma. If this assumption is not valid, risks may be greatly overestimated.

The model used to project the risk of mesothelioma assumes that the risk from any given increment of exposure increases continuously throughout life, which implies that exposures at young ages carry a much higher risk of mesothelioma than exposures at later ages. There are no data to confirm that this actually happens. To the contrary, in the Seidman et al. (1986) study, the risk of mesothelioma peaked at about 35 years following exposure and was less at later years. This study is the most appropriate one available for studying the effect of exposure upon long term risk of mesothelioma because the study involved follow-up to the 1980's of a cohort exposed to intense levels of asbestos during World War II. Other studies (e.g., Selikoff et al., 1979), also suggest that the risk of mesothelioma eventually begins to decrease. A model based on the pattern of mesothelioma mortality observed by Seidman et al. (1986) reduces the estimate of mesothelioma risk under Scenario 1 by a factor of 4.

The scenarios for residential exposure assumed that people would be exposed constantly for 20 years. Thus no allowance was made for the time spent indoors or away from the area.

5.5 SUMMARY

Excess risks of lung cancer or mesothelioma from amphibole exposure related to the Western Vermiculite Mine Project are extremely low. The highest total excess cancer risk, 0.19 per million persons exposed, was calculated for a hunter who smokes and makes 20 consecutive 3-day hunting trips to the vicinity of the mine site over 20 years. The lowest total cancer risk was calculated for a non-smoking resident of Hamilton. These excess cancer risks are based on the premise that health effects from exposure to nonasbestos actinolite and hornblende is generally equivalent to asbestos forms of these minerals. This assumption may be inaccurate and if so, the health risk estimates presented in this health risk assessment are likely to be even lower.

6.0 SUMMARY

6.1 OVERVIEW

The Western Vermiculite Project is a proposed vermiculite surface mine in western Montana. The vermiculite ore deposit for this project, identified as ABM Ridge, contains varying amounts of amphibole minerals. The public has raised the issue of potential health risks from dust emissions due to various mine-related activities. To evaluate this issue, a human Health Risk Assessment (HRA) was undertaken to quantitatively evaluate the potential health risks that could result from the release of asbestos from proposed mining activities. This is accomplished by estimating exposure levels and calculating potential excess cancer risks for selected exposure scenarios.

The data currently available indicate that the amphibole present in the ABM Ridge ore deposits is not present in a fibrous form, and consequently is not classified as asbestos. A fundamental assumption of this health risk assessment is that this amphibole material has the same potential to cause adverse health effects as asbestos fibers. This assumption should not be construed as a conclusion by the authors that this is indeed the case. Since the toxicity of asbestos is thought to be due to its physical characteristics, and particularly its fibrous habit, it is questionable as to whether the health effects associated with asbestos exposure could be caused by the amphibole present at the ABM Ridge. However, the conservative assumption that exposure to ABM Ridge amphiboles is equivalent to asbestos exposure is made because there is currently insufficient experimental and epidemiological information to adequately quantify potential health risks from these specific amphibole minerals.

Exposure point concentrations are based on air dispersion modeling estimates derived from amphibole content of the vermiculite ore and typical dust emission factors for different mining and processing activities. Quantitative health risk estimates are prepared for several residential and recreational exposure scenarios. Population subgroups with special susceptibility to asbestos cancer risks are also considered. The route of exposure selected for evaluation is inhalation. Risk assessment methods used in the HRA are based on recent EPA guidance documents (Risk Assessment Guidance for Superfund Sites 1989) and are intended to obtain health risk estimates for a Reasonable Maximum Exposure (RME) for each of the exposure scenarios which are considered.

Health risks for workers employed at the mine are not addressed in this HRA because mine worker safety is the designated responsibility of a specific federal agency, the Mine Safety and Health Administration (MSHA).

6.2 MINERALS OF CONCERN

Mineral characterization studies performed by Stansbury Holdings Corporation indicate the presence of several amphibole minerals in the ABM Ridge vermiculite ore deposit. Hornblende, cummingtonite-grunerite and actinolite are present in highest concentration, and these minerals are reported in nearly every sample. Tremolite and anthophyllite are generally present at much lower concentrations and are present in only a few samples. None of this material has been found to have an asbestiform habit.

Environmental sampling data are very limited except for the ore body itself. Air, water and soil samples collected from the area of interest are too limited in scope to be used in a quantitative risk assessment. The only environmental sampling data which are suitable for quantitative risk assessment are the analyses sponsored by the U.S. Forest Service (USFS) and Montana Department of State Lands (DSL) to evaluate asbestos content of the ore. These analyses were performed by RJ Lee and show the presence of

actinolite and hornblende at low concentrations in several ore samples. These datasets appear to be of sufficient quality to prepare a health risk assessment. The amphibole structures of potential concern are therefore actinolite and hornblende, and the datasets used presented in the two RJ Lee reports are used to estimate possible exposure point concentrations in the areas of interest.

6.3 EXPOSURE ASSESSMENT

Offsite dispersion of airborne fibers is the major exposure pathway for this risk assessment and the only pathway selected for quantitative evaluation. Inhalation is the primary route of exposure. Releases are considered to occur from several mine-related activities, including mining, transportation, and exfoliation. Exposure scenarios considered for this risk assessment are residential and recreational exposures. Smokers and children are identified as susceptible sub-groups of the population. Exposure point concentrations are developed using estimates of amphibole fibers/gram of ore, dust-emission factors for various mining and processing activities, and air dispersion modeling results. Exposure point concentration estimates range from 1.1×10^{-3} fibers/cc near the mine site to 8.2×10^{-8} fibers/cc near the exfoliation plant in Butte. These estimates are used in Chapter 5.0 to characterize potential excess cancer risks for the exposure scenarios which were selected for evaluation.

6.4 TOXICITY ASSESSMENT

Occupational exposure to several types of asbestos is associated with an increased incidence of fibrosis, mesothelioma, and lung cancer. Exposure to amphibole minerals from the Western Vermiculite Project is projected to be extremely low, so cancer is the only potentially relevant adverse health effect. After evaluation of various methods to derive cancer potency factors for asbestos exposure, cancer potency factors selected were the ones used by EPA. Effects of smoking upon lung cancer caused by asbestos exposure are accounted for by making separate estimates for smokers and non-smokers.

6.5 RISK CHARACTERIZATION

Excess risks of lung cancer or mesothelioma from amphibole exposure related to the Western Vermiculite Mine Project are extremely low. The highest total excess cancer risk, 0.19 per million persons exposed, was calculated for a hunter who makes hunting trips to the vicinity of the mine site for 20 consecutive years. The lowest total cancer risk was calculated for a nonsmoking resident of Hamilton. These excess cancer risks are based on the premise that health effects from exposure to nonasbestos actinolite and hornblende are generally equivalent to that from asbestos forms of these minerals. This assumption may be inaccurate and if so, the health risk estimates presented in this health risk assessment are likely to be even lower.

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APPENDIX A1

R.J. Lee Analytical Data

TABLE I

Compositional Table

Our#	MT#	Tremolite	Actinolite	Hornblende	Mg-Si	Carbonate	Other
8909	#1	—	—	1.1	—	19.0	79.9
8910	#2	—	.9	18.8	—	24.7	55.6
8911	#3 *	—	—	20.7	—	19.6	59.7
8912	#5	—	—	6.5	—	7.3	86.2
8913	#7	—	—	14.7	—	38.5	46.8
8914	#8	—	1.8	21.9	—	19.5	56.8
8915	#9	—	.2	24.9	—	18.7	56.2
8916	#10	—	1.4	2.6	—	30.2	65.8
8917	#11 *	—	—	15.6	—	27.0	57.4
8918	#12	—	6.6	4.3	—	64.8	24.3
8919	#13	—	.4	20.6	—	19.3	59.7
8920	#14	—	1.4	.3	—	36.9	61.4
8921	#15	—	7.1	9.9	—	24.8	58.2
8922	#16	—	29.2	2.4	—	33.2	35.2
8923	#17 *	—	—	13.4	—	29.4	57.2
8924	#18	—	.4	20.8	—	23.9	54.9
8925	#19	—	.2	19.0	—	21.0	59.8
8926	#20	—	.4	21.5	—	20.3	57.8
8927	#21	—	—	24.8	—	20.3	54.9
8928	#22	—	2.0	2.4	—	36.5	59.1
8929	#24 *	—	.7	1.1	—	20.2	78.0
8930	#25	—	—	15.3	—	13.0	71.7
8931	#26	—	2.6	13.8	—	30.3	53.5
8932	#27	—	1.7	23.2	—	25.7	49.4
8933	#28	—	.3	20.9	—	19.3	59.5
8934	#29	—	.5	13.5	—	22.1	63.9
8935	#30	—	.5	12.3	—	26.0	61.2
8937	#62	—	1.5	22.8	—	18.4	57.3
8938	#67	—	.1	16.4	—	26.6	56.9

* Samples also analyzed by TEM

TABLE II

Volume % Federal Fibers

Our#	MT#	Tremolite	Actinolite	Hornblende	Mg-Si	Other
8909	#1	ND	ND	.01	ND	1.1
8910	#2	ND	.030	.31	ND	.63
8911	#3	ND	ND	.35	ND	.71
8912	#5	ND	ND	.01	ND	.82
8913	#7	ND	.005	.4	ND	1.55
8914	#8	ND	.011	.25	ND	.78
8915	#9	ND	.005	.31	ND	.84
8916	#10	ND	.003	.06	ND	.49
8917	#11	ND	.008	.17	ND	.78
8918	#12	ND	.073	.172	ND	.35
8919	#13	ND	.004	.146	ND	.36
8920	#14	ND	.002	.01	ND	.24
8921	#15	ND	.11	.32	ND	1.31
8922	#16	ND	.50	.18	ND	.42
8923	#17	ND	ND	.06	ND	.91
8924	#18	ND	.07	.34	ND	.63
8925	#19	ND	.025	.34	ND	.77
8926	#20	ND	.014	.58	ND	.65
8927	#21	ND	.02	.57	ND	.64
8928	#22	ND	.003	.06	ND	.49
8929	#24	ND	.008	.013	ND	.60
8930	#25	ND	.006	.23	ND	.78
8931	#26	ND	.17	.46	ND	.74
8932	#27	ND	.02	.14	ND	.97
8933	#28	ND	.05	.28	ND	.83
8934	#29	ND	.023	.34	ND	.73
8935	#30	ND	.04	.65	ND	.75
8937	#62	ND	.011	.51	ND	.24
8938	#67	ND	.011	.24	ND	4.61

ND None Detected

TABLE III

Volume % True Fibers

Our#	MT#	Tremolite	Actinolite	Hornblende	Mg-Si	Other
8909	#1	ND	ND	ND	ND	ND
8910	#2	ND	ND	ND	ND	ND
8911	#3	ND	ND	ND	ND	ND
8912	#5	ND	ND	ND	ND	ND
8913	#7	ND	ND	ND	ND	ND
8914	#8	ND	ND	ND	ND	ND
8915	#9	ND	ND	ND	ND	ND
8916	#10	ND	ND	.0005	ND	.003
8917	#11	ND	ND	.02	ND	ND
8918	#12	ND	ND	ND	ND	ND
8919	#13	ND	ND	ND	ND	ND
8920	#14	ND	ND	ND	ND	.0001
8921	#15	ND	ND	ND	ND	ND
8922	#16	ND	.009	.04	ND	ND
8923	#17	ND	ND	.005	ND	ND
8924	#18	ND	ND	.022	ND	ND
8925	#19	ND	.002	.007	ND	ND
8926	#20	ND	ND	.009	ND	ND
8927	#21	ND	ND	.003	ND	ND
8928	#22	ND	ND	.0004	ND	.0024
8929	#24	ND	ND	ND	ND	ND
8930	#25	ND	ND	.002	ND	.003
8931	#26	ND	.004	ND	ND	ND
8932	#27	ND	ND	.003	ND	.003
8933	#28	ND	ND	ND	ND	ND
8934	#29	ND	ND	.006	ND	ND
8935	#30	ND	ND	.005	ND	ND
8937	#62	ND	ND	ND	ND	ND
8938	#67	ND	ND	ND	ND	ND

ND None Detected